

Kurz Instruments, Inc.



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Portable Thermal
Anemometer
User's Guide
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Covers PTA 1.0x
Firmware

December 22, 2000

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Introduction

The Kurz Instruments 2440 series portable thermal anemometers are point velocity sensing devices. This bivariable transmitter also measures the process temperature. The flow element is a constant temperature thermal anemometer which intrinsically measures the process fluid Reynold-s number. The net meter response is mass rate per unit area. The engineering output may be scaled or viewed to represent standard velocity, standard volumetric flow or mass rate. Density changes are automatically accounted for, negating the need for pressure and temperature compensation. A complete description of how and what the thermal anemometer measures can be found in Appendix A. The units must be calibrated in the gas type to be measured or may be correlated from Air calibrations if available. The process temperature measured with this series will read accurately (within a few degrees C) above 100 SFPM (0.5 SMPS) velocity. The unit has an optional I/O module for digital or analog outputs.

The unit has a 32 Wh battery which will provide over two hours operation even with the large metal sensors at high flow and much longer with the ceramic sensor. It has a 12 VDC nominal charger input which takes about three hours to recharge from either an AC wall adapter or an optional vehicle power adapter.

Data logging is a significant part of the firmware for this portable. The unit not only supports external logging using a PC (personal computer) program (i.e. 451022-1.1) and the L command, but has an internal logging memory permitting up to 1500 records to be logged (velocity, flow, temp, and time).

Important Issues for Accurate Flow Measurements

- Duct Velocity Profile Correction:
 - Does velocity profile change with dampers, fans, valves, etc. where the sensor is measuring?
- Sensor Insertion Location:
 - What part of the profile is to be measured?
- Duct Area:
 - Sensor blockage, reducing the effective area.
- Flow & Temperature Output Range:
 - What scale do you want the 4-20 mA output set to?

- Field Calibration:
 - From a field calibration, either velocity dependent correction factors or a simple gain correction can be entered to account for the duct flow profile.
- Sensor Pitch or Orientation to the Flow:
 - Is the flow arrow pointing in the same direction as the flow?
- Medium to be Measured:
 - Was the unit calibrated in the medium to be measured?
 - Is the medium composition highly variable?
 - Does the medium change phase?
 - Can material build up on the sensor?
 - Are there large temperature variations?
- Kickout Values for the NE-43 Alarms (< 3.6 mA and > 21 mA)?
 - What high/low values indicate a meter malfunction or a high/low flow trip point.?
 - What high/low values indicate normal operating conditions?

Answers to many of these questions can be found in this manual or its appendices. Kurz customer service may also be contacted for assistance (831-646-5911 or FAX 831-646-1033, service@kurz-instruments.com). This summary guide covers setup, configuration, operation, calibration and troubleshooting. Many of the terms and abbreviations used in this manual may be found in the Glossary.

The intended audience for this manual is process engineers and instrumentation technicians who are measuring gas flow, HVAC applications etc. The Appendix of this manual has the menu state diagram, signal flow diagram, field wiring diagram, in-situ velocity traverses, Modbus commands and a tutorial guide on what a thermal anemometer measures.

The 2440 is designed as a non-incendive device which means it may be used in Class I, Division 1 areas or Zone 2. As such, it should not be used for flammable gas measurements which require a higher level of safety design like explosion proof or intrinsically safe. The 2440 safety approval is not available yet. The unit is being sold for non-hazardous gas measurements only, even though it will work on any gas and can be calibrated for any gas.

Basic Operation

The 2440 is a straight forward unit with intuitive user interface. You just plug in the sensor and press the power button and back light if it improves the LCD viewing. Note that each 2440 has a serialized sensor that must be matched to its electronics. You can not interchange sensors with 2440 display units and preserve the rated accuracy. The unit takes about eight seconds to boot up and will initially display an LCD display driver screen which is cleared and is followed by the firmware level (PTA VER 1.0x) and *Executive State* scroll. The *Executive State* will scroll through its 3 available METERS, time/date and help prompt: The three METERS represent the following:

METER 1 Velocity

This is a point velocity measurement at the sensor. This is the primary use of this portable. The unit has a low velocity cutout, which forces the reading to zero when below the user selected value. The factory default is 0 SFPM (0 SMPS).

METER 2 Flow Rate

This is based on the idea of an average velocity measurement multiplied by area. You may also add correction factors to account for changing velocity profiles. This meter also has a low flow cutout preset to 0.

METER 3 Temperature

This is the ambient temperature at the sensor. This measurement is valid with process gas flowing across the sensor. At zero or low velocities, it will read too high due to interference from the heated velocity element, as such, there is a user programmable low-velocity cutout for the temperature. At zero flow you will see TEMPERATURE NOT VALID on the screen under these low velocity conditions. The factory default is 100 SFPM (0.5 SMPS)

The reading of any parameters shown in the *Executive State* scroll may be held by pressing the **H** or hold key. When done viewing in hold mode, you may clear this by pressing the **C** or the clear key.

If you access the keypad and press the **D** function key, this will permit viewing of the METER data for velocity, flow or temperature. Pressing the **P** function key accesses the *Programming mode*. The user code is "A123456" followed by the **E** key to accept this code. If either mode is selected and there is no keypad action within two minutes, it will revert to the *Executive State*. It is important to know that while in *Program mode*, the

outputs (4-20 mA) will not update and will remain frozen at their values when you first entered the *Program mode*.

All of the above menus may be accessed via the RS-232 or RS-485 ports using a terminal emulator program. You can set the baud rate between 1200 and 38.4 k. The menus/screens will roll up on the terminal screen as time passes. The function keys in terminal mode are the same as the 4x5 keypad but in lower case. There is also a command which will turn off the display or echo of the display characters to the serial ports. This is accomplished by pressing the **A+@** key, (shift +). Pressing this again will toggle it back on. The unit still responds to the keyboard commands q, l, ?, + and escxxx when the echo is off. The up arrow **^** (shift 6, above the 6 key) is the same as **YES** and will move you from one screen to another. Alternately you can use the down arrow **v** (small v) or **NO** to move from one screen to another in the opposite direction. A summary of these single key commands can be found by pressing “?” from the terminal keyboard.

Navigating the Menus

Pressing **P** or **D** will advance the menu categories forward in that mode one screen at a time without changing anything. If you continue pressing the keys, you will end up back where you started. If you overshoot the menu category of interest, you can backup (**v** key). Alternately, you can also move forward with the (**^** key). Once you enter a menu category within *Program* or *Display mode* you can only advance the screens with the **D** or **P** key depending on the mode you're in. The **^v** keys within the menu categories are used to change entries or selections.

Selecting Menus

You select a menu category of interest by pressing the **E** key or Enter on the remote terminal. Sometimes you have the option of choosing more than one meter, or output before entering a menu. At these screens the **^v** keys will change the specific menu you first enter. Some menus accept direct number input from the keypad or terminal. To deselect or get out of a menu you press the **C** key once or twice depending on the menu.

Entering Data

You enter data into a menu by typing the number directly from the keypad, including decimal points. The **^v** arrow keys will also change values. When you first enter a menu, the most significant digit is changed by the **^v** keys. If you press a number it automatically is entered starting at the most significant digit then it moves the entry point to the right one character. At any time you may change the last entered value with the **^v** keys.

For menus with multiple selections, the **^v** keys are needed to change the selection.

Once you have entered the number or selected the parameter of interest, the value is accepted by pressing the **E** or enter key.

Note: When entering meter IDs or other text using a remote terminal, you must use upper case characters only. The lower case are used for the keyboard commands.

Clearing Data, Editing Data or Exiting Menus

The **D** or delete key will clear one character to the left just like a backspace key on a computer. The **C** key will clear the whole value in a menu. Pressing the **C** key a second time will exit the menu without any change.

Holding a Menu For Display

You may freeze or hold any menu beyond the two minute auto-return interval to view the information like flow rate or temperature by simply pressing the **H** key. This mode is removed by pressing the **C** key.

Help Display

A list of local commands can be found by pressing the **H** key twice or **HH**. The help screens list the firmware revision level, Sensor S/N, Kurz telephone and FAX numbers, website address and menu instructions.

Flow Meter Time Constant

There are four different factors controlling the speed of the meter.

- \$ Sensor Response Time (see Brochure)
- \$ ADC Sample Rate (see programming section for adjustments)
- \$ 4-20 mA Output update rate (see Brochure)
- \$ METER Filter time constant (see programming section for adjustments)

Depending on the various settings, you can have a response time which is sensor limited or over damped using the METER Filter. The net response is the cascade of all the above. So even if the METER Filter time constant is at 0 seconds, the sensor will still limit the response time.

Data Logging

The 2440 is designed for both internal logging with its test-set memory, trend memory and events or externally via its serial port to a PC. The following section describes the external logging and is described in the chapter on *Program mode*.

External Data Logging

The optional log command is the **L** key from the local keypad. You get a summary of the meter, ID, rate and totalization. From a remote terminal this can be initialized using the **Al@** key, lower case L. This output from the L command is fairly fast and can be used instead of the 4 to 20 mA output if you do some text parsing.

Kurz Instruments, Inc. has an optional Windows PC program (# 451022) which will poll the 2440 using the L command and write the data to a file on the computer. The program will also average the data after it has been captured to reduce the file size. Averaging can be on a fixed number of records or a fixed elapsed time. The format of this file can be read directly into a spread sheet program (space delimited data with all METERS on one line or record).

This external log can be set to start on its own by setting a log interval starting at one minute up to 999 hours. The format is hhh:mm on the display and you first enter the hours in a menu screen followed by the minutes (up to 59) menu screen under *Program mode*.

Example data from the 2440 log function or the L command:

```
Host issues  l (lower case L)
Reply:      TIME: 13:58:34 9/18/2000
```

#1 FT456 256.78 SFPM
#2 FT456 0.23459 SCFM 1.238999e3 SCF
#3 TT456 125.71 DEGF

Format:

Time & Date:	"Time:" hh:mm:ss mm/dd/yyyy
Velocity METER data	Number, ID, Velocity, Velocity units
Flow METER data:	Number, ID, Rate, Rate units, Totalization, Tot. units
Temp. METER data	Third METER data (typically temperature with no totalization)

The L command is issued each time you want the data or use the logging interval to have results sent to a computer or printer. If the terminal echo is turned on, (+ command), you will have to parse the above information from the other display data. The phrase "LOGGING DATA TO TERMINAL" will precede the above response and may show up between the lines of the data. By not using the terminal echo, you can get a clean uncluttered answer to the L command. The + command is a toggle for echo on and off operation.

The "e" in the totalization number is short hand scientific notation for "x 10ⁿ". So the number 1.234567e3 is 1.234567 x10³ or 1.234567 x 10³.

Internal Logging

This is one of the most popular features of the 2440 to log data without an external data logger or PC etc. See the programming section for and in depth discussion and examples of data transferred to a PC, spreadsheets and trend plots.

Calibration

The 2440 hardware has an electronics calibration describe next and a flow calibration described in another section.

Calibration of the Analog Output

Operates similarly to the Series 155 Mass Flow Computer. You enter the menu under *Program mode* and must use an external meter to Adial in@ the 4.0 mA Zero and then the

20.0 mA Span. The **^v** keys are used to raise or lower the output until it matches the two conditions listed. Once they are in agreement, you press the **E** key to accept this value. The programming section has a long version of this calibration procedure.

Calibration of the Analog Input

There is no user calibration of the inputs. This is a Factory process only. If your transmitter is reading the ambient temperature within a few degrees when the flow rate is higher than 100 SFPM (0.5 SMPS), then the input is properly calibrated and your sensor is most likely working too.

External Communications To The Portable

The field wiring diagram for the 2440 is drawing 342035 found in the Appendix. Besides showing the charger and sensor connections, examples of how the optional I/O adapter is used are provided. The adapter has the following external data connections:

- RS-232 with DB-9 connector for a straight cable connection to a typical PC
- RS-485 with screw terminal clamp wire connections for a network using the optional Modbus protocol.
- 4-20 mA outputs 1 and 2 which can be flow, velocity, temperature or even two ranges of the same variable.

The serial port can be RS-232 or RS-485 but not both at the same time. The jumper on the I/O board selects which serial data standard is used. The baud rate and protocol are specified in *Program mode*. Typically the RS-232 port is used to transfer data stored in the internal trend or test (also known as test-set) memory to a PC for permanent storage, further manipulations and graphing with a spread sheet program (see subsequent examples).

The analog outputs are loop powered and isolated. They are factory calibrated but may be field set in *Program mode*. These outputs would typically be connected to a data recorder or chart recorder. Several examples on how to wire up these ports are provided in the field wiring diagram, 342035 found in the Appendix.

Modbus Industrial Network Protocol

The Modbus mode of communications is used with the RS-232 (point to point) or RS-485 (point to point or multipoint). The 2440 supports both the ASCII and RTU versions

of Modbus. When configured in this mode, it will **not** operate as a Remote Terminal or perform Data logs or its Upload/Download functions.

The RS-485 can be configured as Full Duplex (4 wire + GND) or Half Duplex (2 wire + GND). Modbus is a network communication protocol that was developed by Modicon for their controllers. The controllers can communicate using a master-slave technique in which only one device, the master, can initiate transactions, called queries. The other devices, slaves, respond by supplying the requested data to the master or by taking the action requested in the query. The master can address individual slaves, and the slave will respond by returning a message or response to the query that is individually addressed to it. The Modbus protocol establishes the format for the master's query by combining the device address, a function code defining the requested action, any data to be sent, and an error checking field for the data packet. The slave's response message is also constructed using Modbus protocol. It contains a field confirming the action taken, any data to be returned, and an error checking field. If an error occurred in receipt of the message or the slave is unable to perform the requested action, the slave will construct an error message and send it as the response. You can find more details on the protocol at the Modicon website www.modicon.com where an on line version of the PI-MBUS-300 standard is available.

Battery Discharge, Charge and AC powered

The battery discharge or operational time of the 2440 will depend on the sensor load (sensor type, flow rate and process temperature). Switch mode power supplies are used throughout the 2440 to make efficient use of the battery energy. With the metal clad sensors (2443, 44, 45) you will have over two hours operation on a charge. The ceramic sensors (2441, 42) will work almost four hours on a charge. The 2444 is shown on the front cover of this manual.

As a battery powered portable device, the 2440 must be charged to work properly. Typical fast charge from a dead battery will occur in three hours. The fast charge will refill the battery to about 90% charge with the trickle charge doing the rest. If the unit is too cold (below 0 °C) or hot (battery > 50 °C) it will not start the fast charge. The LED near the 12 VDC charger input indicates fast charge. If 12 V is applied to the charger input and it is not in fast charge, then the battery is being trickle charged. This is low enough in current as to do no harm to the battery even when left on past the fast charge time indefinitely.

The 2440 has an automatic shutdown when the battery has been discharged below 0% charge to protect the battery and will not restart until partly charged or enough time has passed for the battery to partly recover.

The AC powered charge adapter has a universal input accepting 100 to 240 VAC, 50/60 Hz. The 12 V charge adapter has a standard IEC 2-pin plug that will accept any local power plug. See the 342035 wiring diagram for the cord part number in your area.

The unit will operate when charging, but since some of the charge current is being diverted to operate the unit, the battery may not reach a full charge before the charger control circuit times-out (3 hours). Once the charger times-out or thinks the battery is fully charged, it switches to trickle charge mode. If the unit is left on, it will eventually discharge the battery then shutdown, even though the charger is plugged in. The trickle charge is not enough to overcome the 2440 load even at low flow. Whenever the 12 VDC power is cycled, the charger will reset and attempt a fast charge on the battery.

If you want a full battery charge during one charge cycle, you must keep the unit off while charging. Due to the temperature limits on battery charging (0 to 50° C), to ensure a full charge, allow the unit to reach room temperature before starting a charge.

Multiple batteries may be used with the 2440 but they must be charged in the main unit as described above then unplugged for external storage. As the unit charges quickly and will operate when the charger is plugged in, the need for multiple batteries is not common.

Externally Powered

To operate the portable continuously, the charger (AC or Vehicle) will provide the power but it must be fooled into staying on. The internal 2440 charger will stay on in standby mode (the state it goes into after a power cycle on the 12 V input) by removing (unplugging) the battery. Without the battery present, the charge circuit will operate the 2440 continuously with any sensor at any flow rate.

The battery cover is held on with four #2 cross point head screws. The battery is further held in place with foam to keep it from rattling in its case. It is important to note the polarity on the battery connector when removing. Plugging in with the pins off by one may damage the unit. The wrong polarity (whole thing backward) will not damage the unit, but it will not turn on from the battery.

Charge Status

The temporary menu screen:

WARNING!!!

BATTERY IS LOW

will come on for a few seconds every few minutes below 20 % charge. The unit will continue to work below 0 % charge but not for long. The automatic shutoff will eventually trip to protect the battery from excessive discharge. You may view the battery status anytime under *Display mode* following the temperature meter.

**BATTERY CHARGE:
100 PERCENT**

As with most portable devices, the percent charge is approximate based on the battery voltage. Since this is not temperature corrected, there will be some error when the battery is below or above room temperature. The charge status is based on a 20° C voltage discharge curve. When the battery is cold, its voltage is lower so the indicator under estimates the charge and above room temperature, the voltage is higher so the charge status over estimates the true charge.

Configuration Data Storage

The configuration data is stored two ways in the 2440 (See figure 1). The primary method is a battery backed up CMOS RAM or SRAM. All information about the flow meter is stored in this memory. In addition, the original Factory configuration is stored in the EEPROMs located on the analog input and output boards of the unit. These can be used in the event of corruption of the RAM. Meter settings, IDs, Area, Alarms etc are not stored in EEPROM, only SRAM.

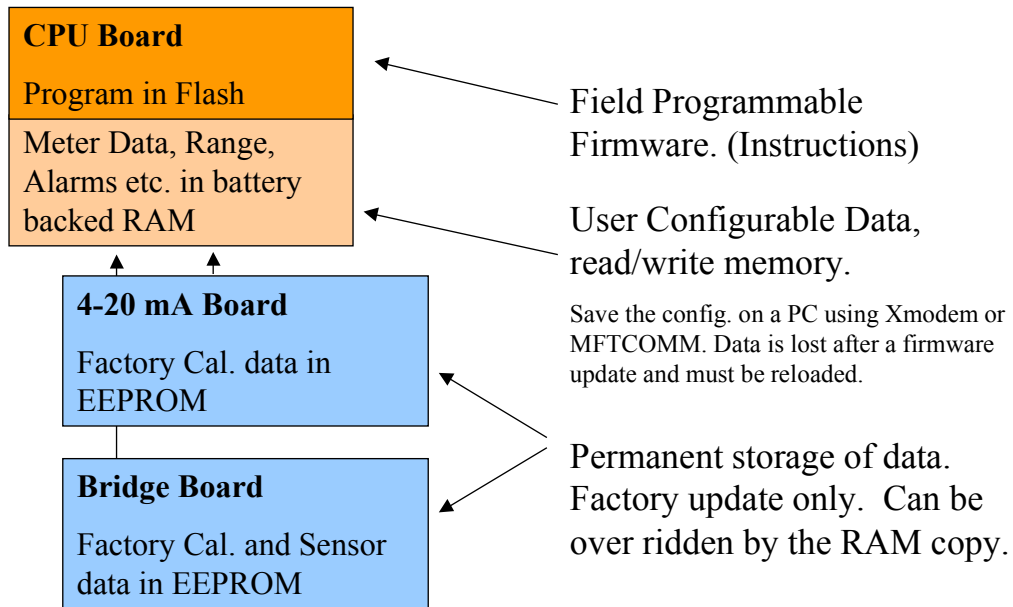


Figure 1. Memory Configuration.

To access the EEPROM memory and completely replace the SRAM content, you must enter to the *Program mode* and select the menu item **APRESS E TO LOAD DATA FROM EEPROM®**. The menu will ask you if you want to reload the data from the EEPROM to the RAM. Press the **YES** key followed by the **E** key to initiate the data transfer. After the process, the data in the RAM will be the same as the data in the EEPROM (Factory data).

An external method of saving or restoring the configuration is available with the upload/download process via a PC terminal emulator program described next or using MFTCOMM (#451015) in Appendix C.

Configuration, Upload/Download

The upload/download process allows you to save not only the Factory data but your field customization in a remote file on a PC.

The easiest way to do this is to install and use MFTCOMM (#451015) version 1.4x or higher described in Appendix C. This is a Windows program (NT/Win98/95) provided on a 3 2" floppy disk containing the Factory configuration of your unit. This program will also allow you to make a printable hardcopy of the setup.

If you do not have MFTCOMM or do not want to use it, you can use a terminal emulator program with Xmodem. This will transfer a binary file of about 2.2 kbytes in five seconds at 9600 baud. To initiate this you enter the command:

EscuploadRet

That is the Aesc@ or escape key on your keyboard followed by the text Aupload@ then the enter key or return key. You will be prompted that it is ready to start the Xmodem receive on the PC. If you spend too much time (more than 60 seconds) getting started, you will have to issue the command again.

To copy this configuration back into the unit, use the command:

EscdownloadRet

That is the Aesc@ or escape key on your keyboard followed by the text Adownload@ then the enter key or return key. You will be prompted that it is ready to start the Xmodem transmit file on the PC. Again you have 60 seconds before it times out.

The above commands are effective only when the Series 2440 is in the *Executive Mode*. It is recommended to turn OFF the terminal echo during this process to avoid dumping character strings on the terminal screen. Refer to the section *Overview of the user Interface* on how to turn the terminal echo ON and OFF.

THE NEW 2440 SERIES

PORTABLE AIR MEASUREMENT INSTRUMENTS WITH "SMARTS"

NEW PORTABLE AIR VELOCITY METER!

The industrial-grade Series 2440 Thermal Anemometer is an accurate and reliable instrument for industrial hygiene, HVAC, boiler combustion air flow, and other applications. It measures velocity, mass flow, and temperature within 1% at temperatures from -40°C to $+500^{\circ}\text{C}$. With a storage capacity of up to 1,500 data points and spreadsheet compatibility, it is also ideal for velocity traverses/flow studies. It is available with a 13" length or a "goose-necked" 43" extendable fast response ceramic probe, a rugged 13" length or a 60" sectional metal-clad probe, or a high temperature metal-clad sensor. Input/Outputs are 4-20 mA, RS-232 or RS-485. The "smart" digital portable comes with a carrying case and universal AC charger. The 2440 series also has an optional 12VDC auto-



mobile charger. It is fully programmable and the two-line, sixteen-character display can be back-lit at the touch of a button when needed. The Series 2440 may be operated for up to four hours with its rechargeable nickel-metal hydride batteries, or continuously from its AC/vehicle power outlet charger.

The automatic/manual data logging functions, with easy downloading of information to popular spreadsheets, make this the most powerful, versatile portable meter yet from Kurz Instruments.

The User partitionable memory places the operator in full command and control of data storage to allow for efficient manipulation of data whether the application requires event, test, or trend information.

The New 2440 Series: data logging power; Kurz Instruments' outstanding accuracy and repeatability; versatile designs; truly a "SMART" meter.

Model 2441

The Model 2441 is the base model for this series. It comes packaged in a rugged poly carrying/storage case with a $\frac{1}{4}$ inch diameter 13 inch probe with 8 feet of cable and a 115VAC charger. This unit uses the well proven Kurz "CD" Ceramic Dual Sensor.

Model 2442

The Model 2442 comes equipped the same as the 2441 except the "CD" sensor is encased in a flexible 7 inch "goose-neck" section on the end of a wand that extends from 14.5 inches up to 43 inches.

Model 2443

The Model 2443 comes equipped with a rugged Kurz "MD" Mini Dual Metal Clad sensor probe. This sensor probe is $\frac{3}{8}$ inch diameter 13 inch probe and is rugged enough for even harsh and dirty environments.

Model 2444

The Model 2444 uses the "FD" Fast Dual sensor for temps $<400^{\circ}\text{F}$. This is the heavy industrial version of the portable for industrial/dirty environments. This unit has a $\frac{3}{4}$ inch diameter 15 inch long probe with three additional screw-in support sections.

Model 2445

The Model 2445 is a fixed length probe made to order and is designed for temps up to 900°F .

DESCRIPTION

Series 2440 Portable Mass Flow Meters raise the standard for measurement of air and industrial gasses. The industrial-grade 2440 Series Thermal Anemometer is an accurate and reliable instrument for HVAC, boiler combustion air flow, industrial hygiene, and other applications. It measures velocity, mass flow, and temperature within 1% at temperatures from -40 to +500 degrees C. With a storage capacity of over 1,500 data points and spreadsheet compatibility, it is also ideal for velocity traverses/flow studies. It is available with a 13" length or a "goose-necked" 43" extendable fast response ceramic probe, a rugged 13" length or a 60" sectional metal-clad probe, or a high temperature metal-clad sensor. Input/Outputs are 4-20 mA, RS-232 or RS-485. The "smart" digital portable comes with a carrying case and a universal AC charger. It is fully programmable and the two-line sixteen-character display can be backlit at the touch of a button. The automatic/manual data logging functions, with easy downloading of information to popular spreadsheets, make this the most powerful, versatile portable meter yet from Kurz Instruments.

PRINCIPLE OF OPERATION

The Series 2440 uses the well-known Kurz thermal convective mass flow measurement technology, using constant temperature anemometry with newly designed sensor probes, the 2440 series meets the varied needs of the flow measurement professional. Fast response, industrial duty, or high temperature models are designed for the work you do.

APPLICATIONS

- ▶ Clean Industrial and Process Gas Mass Flow
- ▶ Combustion Air Flow Rate
- ▶ HVAC Air Flow Measurement
- ▶ Research and Development
- ▶ NIST Traceable Air Velocity Calibration Standard
- ▶ Air Sampling and Industrial Hygiene Studies
- ▶ Stack Mass Flow Assessments

KEY FEATURES

- ▶ Exceptional accuracy
- ▶ 0 to 18,000 SFPM
- ▶ Process temperature ratings up to 500°C
- ▶ Pressure and temperature compensated
- ▶ Simple 1500+ point data logging capability
- ▶ Velocity/Volume/Mass display capability
- ▶ Temperature display capability
- ▶ English or Metric display units
- ▶ NIST traceable calibrations
- ▶ User changable reference conditions
- ▶ Nickel metal hydride batteries
- ▶ 24 Hour clock/calendar
- ▶ Download data to PC spreadsheets
- ▶ Selectable automatic/manual data logging mode
- ▶ Attitude insensitive
- ▶ Vehicle recharger available
- ▶ Poly carrying case

OUR MISSION

To manufacture and market
the best thermal mass flow meters
available and to support our
customers in their efforts to
improve their business.

"CD" Fast Dual Ceramic Duraflo™ Mass Flow Sensor



OUTPUT CHARACTERISTICS

- The 2440 Series provides optional output signals in:
- 4-20 mA outputs, loop-powered and optically isolated
 - RS-232 Serial port connection
 - RS-485 Serial port connection
 - RS-485 ASCII or RTU protocol



Shown above is a Series 452 Insertion Mass Flow Element with an Alloy C276 "MetalClad" sensor for tough, heavy-duty applications, and the "Smart" 155Jr Mass Flow Computer.

SENSOR PLACEMENT CRITERIA

- ▶ For pipes having an I. D. of 1.5" to 3.5", place the center line of the sensor at 0.5" from the inner wall of the pipe.
- ▶ For pipes having an I. D. greater than 3.5", place the center line of the sensor 15% of the pipe I. D. from the inner wall of the pipe.
- ▶ Use a sufficiently long sensor support to ensure that the surface of the Sensor Electronics Enclosure does not exceed 60° C.
- ▶ Refer to Kurz technical note DCN 364002 to obtain the appropriate sensor blockage correction factor (SBCF), if required.

SPECIFICATIONS

Process Velocity Range:
0-18,000 SFPM

Process Temperature Rating:
MT: -40°C to 500°C

Sensor Material:
Kurz proven "CD", "MD", and "LD" ceramic and metal-clad

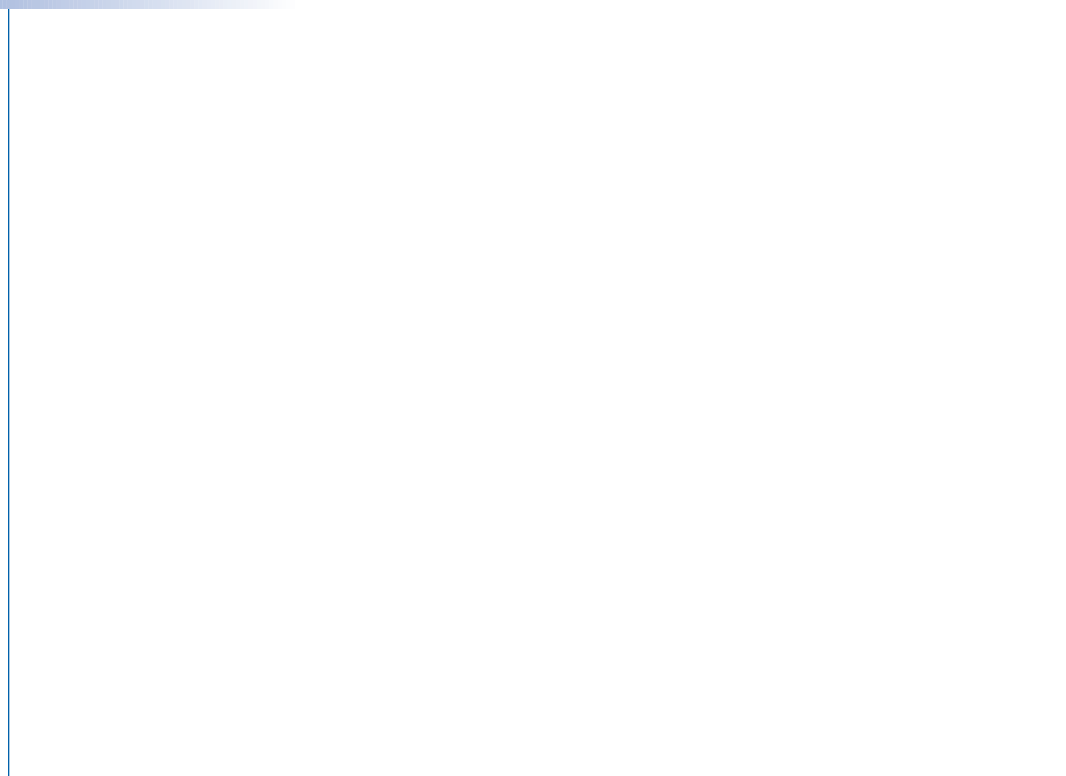
Sensor Support Material:
316L Stainless Steel
Alloy C276

Repeatability: 0.25%

Response Time (One TC):
Velocity: model dependent
50ms - 1 sec
Temperature:
300ms - 3 sec

Power: NiMH rechargeable

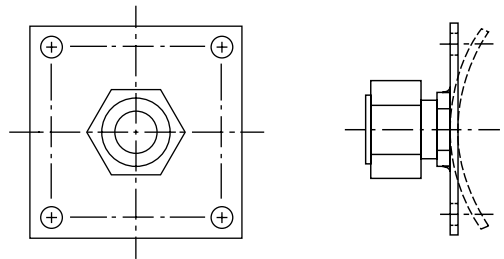
SERIES 2440 MODEL OUTLINES



SERIES 2440 ACCESSORIES

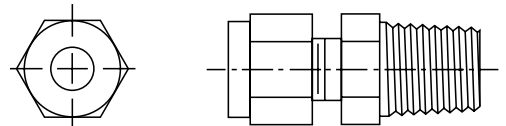
DUCT MOUNTING BRACKETS

These convenient brackets are used to mount the sensor support on flat or curved ducts. 316 Stainless Steel bracket and compression fitting, Teflon, Nylon or 316 SS ferrules. Refer to Drawing No. 759030.



MALE COMPRESSION FITTINGS

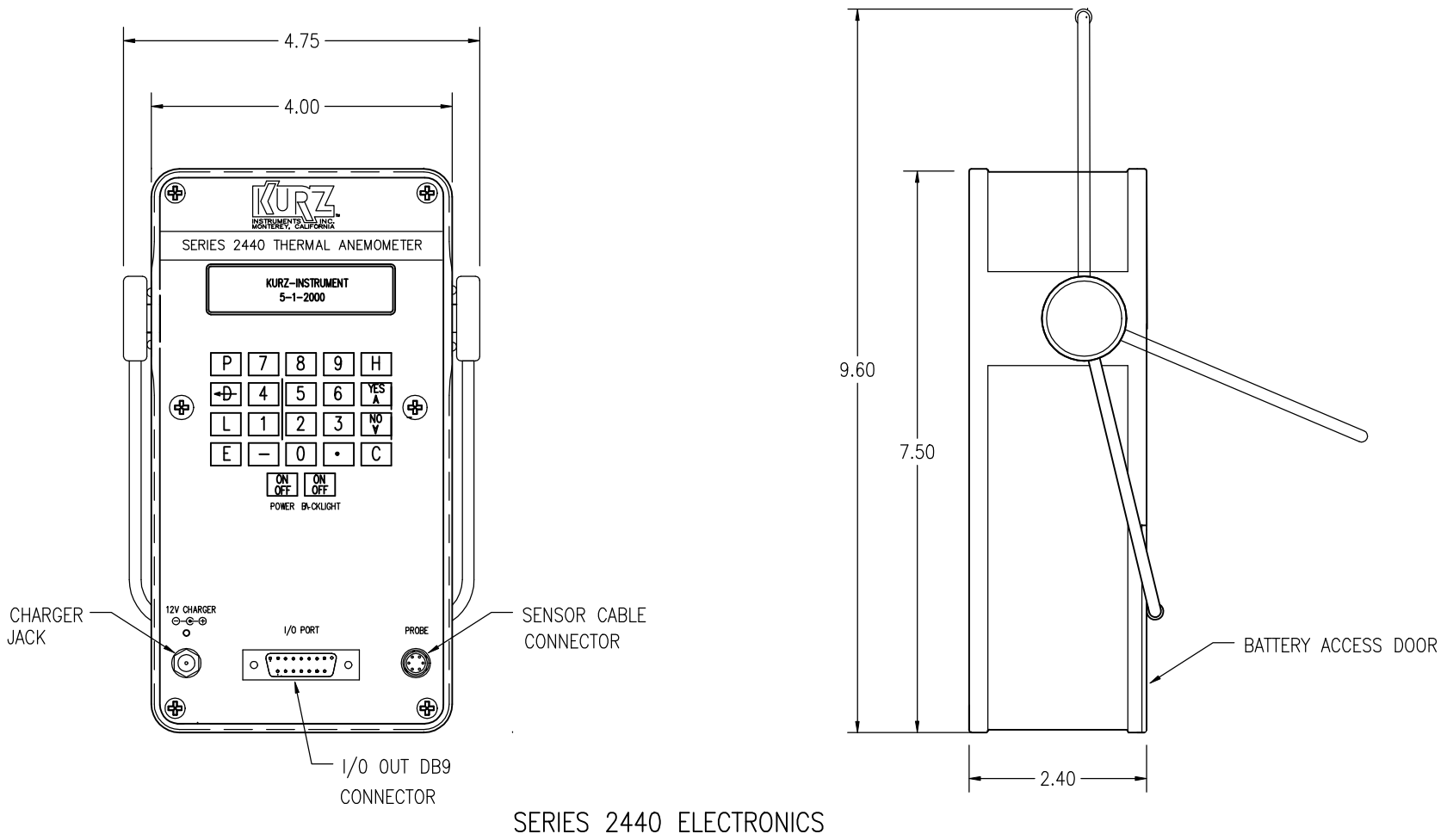
Bored-thru fittings for process use, 1/4", 3/8", 1/2", 3/4" male IPS threads, 316 SS body, 316 SS, Nylon or Teflon ferrules. Refer to drawing No. 759031.



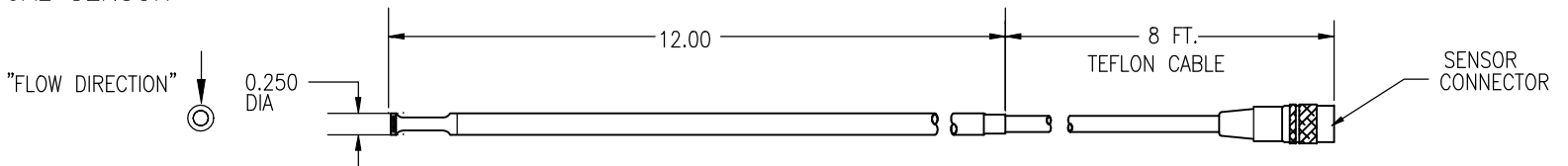
EXTENSION CABLES

Part Number	Cable Length (FT)	Description
260111-01	8	"Quick-Couple" extension cables made to provide the flexibility your unique process control situation requires.
260111-02	16	
260111-03	24	

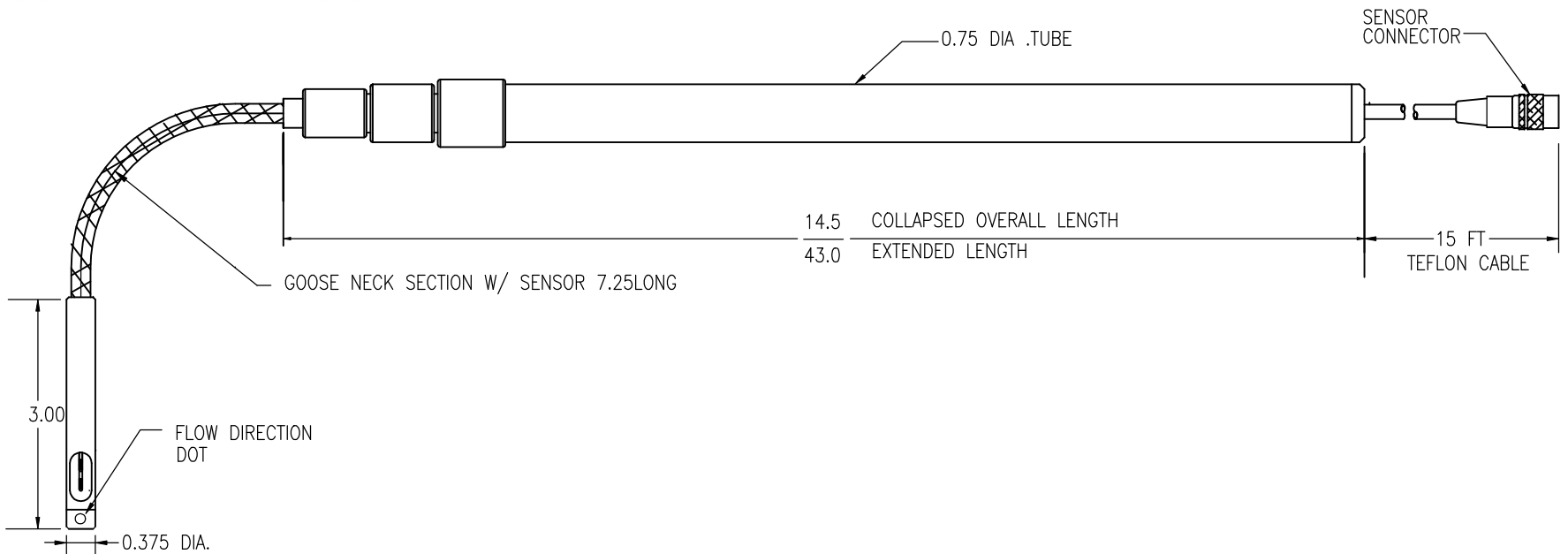
SERIES 2440 OUTLINE DRAWINGS



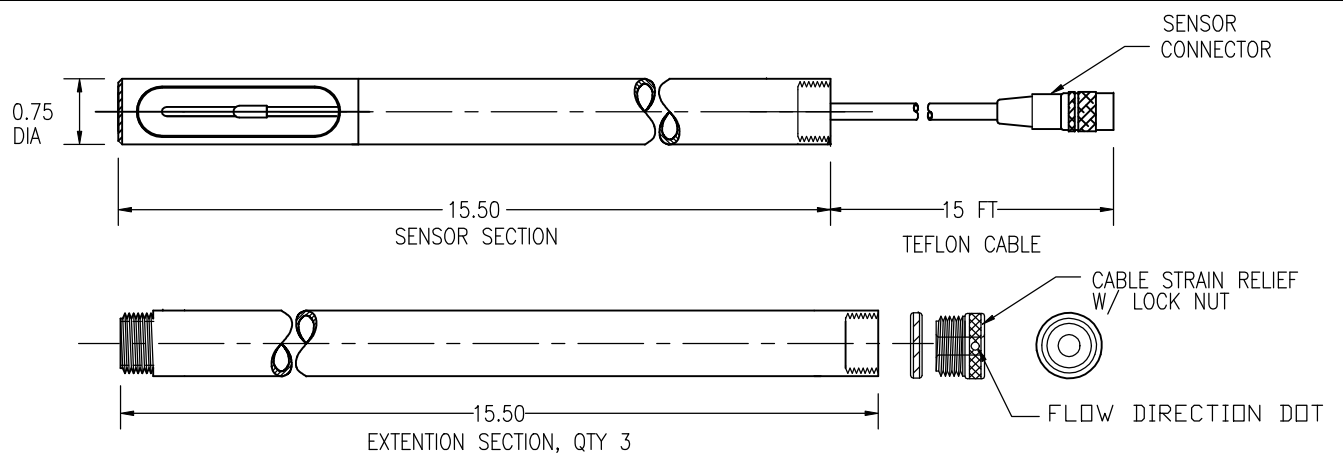
SERIES 2441
CERAMIC DUAL SENSOR



SERIES 2442
CERAMIC DUAL SENSOR (CD)
W/ TELESCOPIC TUBE & GOOSENECK



SERIES 2444
FAST DUAL
METAL CLAD SENSOR
(FD-MT)



Program Mode

After reading over the basic navigation information in the operation and Menu-State diagram in the Appendix, you can setup or configure anything you need for your Series 2440 unit. This section explains what the various parameters are for. Not all functions listed may be available with your unit depending on what was ordered.

Functions Available in Program Mode

All the programming menus and controls are shown on the Menu State Diagram (342034) in the Appendix E and navigation of this was described previously. This is an outline of what you can do in *Program mode*.

System Configuration:

Some of the available features of the 2440 are Factory set parameters that depend on what was ordered. This includes the communications options and the number of analog outputs, enable of the fast ADC rate of 250 Hz, communications modes and external data logging.

Set System Units

You can change the displayed data in either English or metric units. This selection works no matter what units or reference conditions were used for the original calibration data.

Reset Totalizer

The flow or mass totalization and elapsed time is maintained by a set of internal variables, which are battery backed up. This variable has about seven digits of resolution but will totalize for about four years with better than 1% tracking. This menu will reset the flow and elapsed time variables to zero.

Set Time and Date

There is a year 2000 compliant real time clock and calendar, which annotates the display and logged output. This clock has one-second resolution on the internal and external logged data.

Set ADC Sample Rate

The Analog to Digital Converter (ADC) which reads the sensor signal has 16 bit resolution when operating at 50 or 60 Hz data rate. It can reject any power line frequency noise easily when the converter rate matches the power line. This is

generally not an issue unless you have very long wires in a very noisy area

Flow Calibration Data

This menu displays the sensor serial number, Factory calibration reference conditions and permits the user to label the gas name and change the reference temperature, pressure and gas molecular weight. The molecular weight is only used when computing mass rate.

METER 1 Velocity Parameters

This menu is use to select the METER ID or tag, choice of insertion or in-line flow and the velocity dependent correction factors. You can program the velocity or flow rate for the high and low Kick-Out points. The low velocity cut-off value is also programmable. This is useful to prevent zero flow or low flow drift due to temperature and pressure changes.

METER 2 Flow Rate Parameters

These parameters are similar to METER 1 with the addition of a flow area, sensor type and depth for computing a Sensor Blockage Correction Factor (SBCF). The SBCF is a multiplier to the flow calculation to reduce the effective area by the probe projection on to the duct cross sectional area.

METER 3 Temperature Parameters

The temperature METER also has an ID or tag, correction factors and a high and low Kick-Out value. More importantly, the low velocity cut-out is programmed here. Since the ambient temperature is measured with the velocity probe, it will read high a low velocity due to self-heating. To mask this error, it will report "TEMP NOT AVAILABLE" below this set point velocity. It is recommend to keep this at 100 SFPM (0.5 SMPS). The way the unit is designed, if it does not read the ambient temperature with-in a few degrees C of the true temperature with gas flowing across it, then the unit is defective and should be returned for service.

Set METER Filter TC

Each of the three METERS can have a time constant (τ , τ) to reduce its noise. This Time Constant (TC) is like that which applies to an electrical circuit with a resistor (R) and capacitor (C) making a low pass filter, $\tau = RC$. With a step change on the input, after one time constant the output change will reach 63% of its final value. The settling time is about five time constants to reach the final output within 1%.

Calibration of the 4-20 mA outputs

The analog output must have its circuits adjusted so when the flow computer commands zero for and output that you actually get 4.00 mA and similarly when

you request span that you get 20.00 mA.

Set Analog Outputs

The assignment of which analog output is matched to which METER is made in this menu area. There are only two analog outputs which are typically set to the velocity and temperature METERS. You can range the flow, velocity, temperature or mass rate to the Low and High values of the 4-20 mA signals. A METER kick-out low will cause the output to go below 3.6 mA and a kick out high will cause it to go above 21 mA. This is the NE-43 specification.

Set Alarms

Any of the METERS can have Solid State Relay (SSR) alarm contact associated with it. There are two SSRs in this unit which are rated for 0.8 A, 24 V AC/DC. You can alarm on just about any condition from the METER's output. Once assigned, the alarm can be turned On/Off, Normally Open or Closed, HI, Low, HI/Low based on a set point. These alarms are self clearing when the condition changes not requiring a reset.

Load Calibration Data from EEPROM

The Factory calibration data for the ADC, Sensor, 4-20 mA board etc are stored in a non-volatile memory known as an EEPROM. This data is loaded into the SRAM of the unit when new, but may be partly modified by the user. If the SRAM becomes corrupted or you wish to force a loading of the data from the EEPROM you can using this menu. There is one EEPROM on the bridge board which has all the sensor data and one on the 4-20 mA board which has its calibration.

Meter IDs or Tags, flow units, ranges, correction factors etc. are not part of the calibration data stored in these EEPROMs.

Set Communications Mode

The 2440 supports the classic remote terminal mode designed for humans to read and control as well as Modbus which is designed for computers or PLCs (Programmable Logic Controllers) to communicate with it. With the Modbus protocol, you can have many devices sharing the same set of wires, each with its own address (1 to 246) which is set in the menu. Once you select the Modbus protocol, it will stop its terminal mode echo and you can only change it back using the local keypad/display. Both the RTU and ASCII versions of Modbus are supported. In full duplex, you can operate at any Baud rate. In half duplex RS-485, you must be at 9600 or higher for the Modbus to work reliably.

Set Baud Rate

The baud rate for serial communications with RS-232/RS-485 in terminal or Modbus mode is set in this menu. The default value is 9600 but it may be set at 1200, 2400, 4800, 9600, 14.4 k, 19.2 k and 38.4 k.

Set Data Logging

This menu is for external data logging. Here you configure an internal timer to issue the equivalent of the L command which summarizes each METER. This can be set as hhh:mm format for hours and minutes. You may also turn this function off.

Set Memory Data Logging

This menu is for internal data logging to the battery backed up memory. You can specify what percentage of the 1500 data records will be trend data and the balance will be test-set data records.

Access Memory Log.

To record test-set data, view test-set data locally or transfer a file of trend, test-set or event data, you enter this menu.

Executive Mode Scroll

After booting up or turning on, the screen of the 2440 will scroll through the time/date, help prompt screen, velocity METER, flow rate METER, temperature METER then start over.

Entering Program Mode

From the Executive mode, press the **P** key and you will see the following warning message screens. They will hold about 3 seconds long.

**! WARNING NO !
OUTPUT UPDATES**

After approximately 3 seconds you will see the continuation of the warning message.

**WHILE IN
PROGRAM MODE**

After approximately 3 seconds enter the user access code: **123456** and you accept this code with the **E** key.

**ENTER ACCESS
CODE: *******

After you have entered the access code you will see the following category screen.

**PRESS ENTER TO
RESET TOTALIZER**

which will alternate with the message:

**PRESS P TO SEE
NEXT CHOICE OR**

This is the one of many menu categories within the *Program mode*. You navigate to the menu category of interest using the **P** key to advance to the next or you can use the **^v** keys to move forward and backwards. Once at the category of interest you press the **E** key to enter these menu screens. While in *Program mode*, the category or screen will remain at a category or screen for two minutes then automatically exit if there is no user keyboard entry.

Analog Output Range

All flow calculations internal to the Series 2440 use floating point numbers. To connect this large dynamic range to the 4-20 mA analog output (12 bit resolution) we have to specify the low and high scale values. You can assign either or both analog outputs to either or both meters. The standard output range is 4-20 mA. If it becomes saturated, due to process conditions, the output signal is limited to 3.8 mA at the low end and 20.5 mA at the high end. In case of failure, the output signal is forced to less than 3.6 mA or higher than 21 mA depending to the type of failure. These are the NE 43 alarm levels which are related to the high and low kick-out (See section on Low and High Kick-out). You get to the *Analog Out* category from: *Program mode* then press the **P** key until you reach the following:

**PRESS E TO SET
ANALOG OUTPUTS**

You press the **E** key to enter the analog output assignment and scales.

**PRESS E TO SET
ANALOG OUT #1**

At this screen you can select which output you are going to configure using the keypad or the **^v** keys then press **E** to accept.

**ANALOG OUT #1
ENTER METER #1**

In this screen we now select which meter will be assigned to the analog output we previously selected.

**OUT #1 NEXT TYPE
^v FLOW RATE**

In this screen you use the ^v keys to select FLOW RATE or VELOCITY for the output type followed by the **E** key to accept your entry.

**LO=X.XXXXX UNIT
AT 4.000 mA**

This screen is where you set the engineering unit (UNIT) value which will correspond to the low output limit of the 4-20 mA channel. Key in your value or use the ^v keys then press **E** to accept the value.

**HI=XXXXX.X UNIT
AT 20.000 mA**

Now you enter the engineering value you want for the span or 20 mA output current. Key in your value or use the ^v keys then press **E** to accept the value. Press **P** to skip to the next screen where the above menu screens repeat for Output 2.

Analog Output Calibration

Independent of the analog output range or scale there is a calibration where an external meter is used to ensure that when the Series 2440 unit is sending 20.00 mA that it really is. This calibration should use a 4 2 digit DVM that will provide about 0.2 % accuracy for the 4-20 mA current calibration.

1. Connect the current meter to the output number you are working on. The meter must be in series with a power supply to operate the opto-isolated output. See the field wiring diagram DCN 342035 in Appendix D.
2. You get to the *Calibrate* category from: *Program mode* then press the **P** key until you reach the following:

**PRESS E TO CALIB
4-20 mA OUTPUTS**

You press the **E** key to enter the output calibration category.

**SET 4.000 mA TO
OUT 1 UP=[^] DN=^v**

This screen shows that the Series 2440 unit is sending what it thinks is 4.000 mA to Output #1. You use the up or [^] key to increase the sending current if it is too low and the down or ^v key if the current is too high. Each key press will change the output one tick (one bit of 12) at a time. Holding down the key will only change the value one tick using the local display, unlike the Series 155 Mass Flow Computers. In terminal mode you can get more ticks by holding the key. Once it is as close as you like, press the **E** key to accept the value or **P** to skip this screen. The Factory calibration will be so close to what you need that not much change will be required.

**SET 20.000 mA TO
OUT 1 UP=[^] DN=^v**

This screen works the same as the 4.000 mA screen but at the 20.000 mA value.

After you have calibrated Output #1 you will see the screens prompt you for Output #2. You can do this too or skip with the **P** key or the **C** key twice to exit.

Internal Memory Logging

The Kurz Instruments Series 2440 supports logging of data to the battery backed RAM (Random Access Memory). The data that will be logged to the RAM will remain until it is overwritten or the RAM battery is discharged (5 to 10 year lifetime). There are four types of data logging available, they are Events data log, Min/Max (Minimum and Maximum) values data log, Trend logging and Test-set records.

The event log is use to record the events occurred during the 2440 operation. The information that is stored to the RAM for each event occurred (record) contain the following information; the time and date of the event, description, flow rate, velocity, the gas temperature, electronics temperature and the measurement units. This log can save up to 123 records and will retain the most current.

The Min/Max log is use to record the minimum and maximum values of the measured variables, the measured variables are velocity, flow rate, medium temperature and electronic temperature. This log is updated periodically to keep the values up to date.

The Trend log is use to do data trending. The number of samples and the interval time of logging is configurable. The maximum possible number of samples is 1500 and the fastest interval time is 1 second. Samples are continuously stored and the trend log will

retain the last saved samples. Each sample contains a time and date tag, velocity, flow rate, gas temperature and the measurement units.

The Test-set log is use when recording test samples. The data can be logged manually by pressing the **E** key every time you want to record a sample or automatically by specifying an interval time between recording of test samples. The recording of samples will stop once the number of test samples desired is satisfied. Each sample contains a time and date tag, velocity, flow rate, gas temperature and the measurement units. The test-set log is subdivided into different test identification numbers (test ID) and configurable to meet the users need.

The internal logging memory space allocation is shown in Figure 2. This figure shows how you trade-off test-set memory for trend memory.

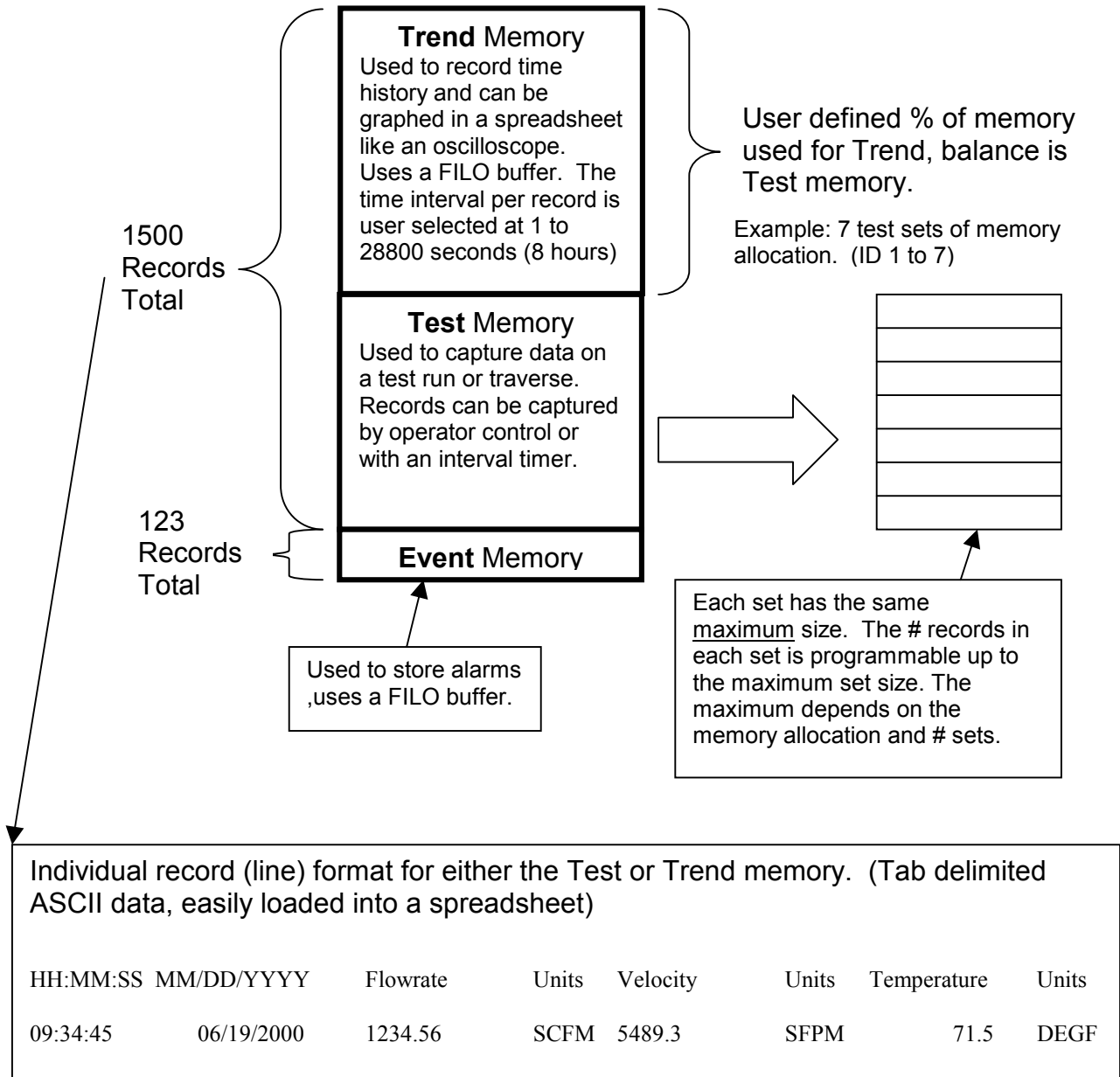


Figure 2. Internal data logging memory organization.

Memory Log Setup

Before you can use the memory log feature, it needs to be setup. The setup can be done in the *Program mode* under the menu category “SET MEMORY DATA LOG”.

Event and Min/Max Log Setup

To setup this log, follow the following instructions:

Enter *Program mode* and scroll through the menu categories using the **P**, **^** or **v** keys until you reach the screen:

**PRESS E TO SET
MEMORY DATA LOG**

Press **E** to see the setup selection display, press **P** or **^** or **v** repeatedly until you reach the display,

**SETUP: EVENTS
NEXT CHOICE ^v**

Press **E** to accept the selection. Select the Event log to ON in the next display,

**EVENTS LOG: ON
^=ON v=OFF**

Press **E** to accept. Select the Min/Max log to ON in the next display,

**MIN/MAX LOG: ON
^=ON v=OFF**

Press **E** to accept. Press **C** to exit to the top of the menu.

Trend Log Setup

Enter *Program mode* then scroll through the menu categories using the **P**, **^** or **v** keys until you reach the display,

**PRESS E TO SET
MEMORY DATA LOG**

Press **E** to see the setup selection display, press **^** or **v** repeatedly until you reach the display,

SETUP: TRENDS
NEXT CHOICE ^v

Press **E** to accept the selection. Select the Trends log to ON in the next display,

TRENDS LOG: ON
^=ON v=OFF

Press **E** to accept. Enter the percent of memory usage in the next display,

ENTER PERCENT OF
MEMORY USE: 0

Enter a number from 0 to 100 percent. The percentage number will determine the size of the memory storage allocated to the Trend log since the total memory allocation is shared with the Test log. For example if the number entered is 50 percent the number of samples that can be stored is 0.5 times 1500, which is 750 samples. Press **E** to accept the entry. Enter the log interval in the next display,

ENTER INTERVAL
TIME(S): 5

Enter the log interval time in seconds, the fastest interval time is 1 second and the slowest interval time is 28800 seconds or 8 hours. Press **C** repeatedly to exit to the top of the menu.

Test Log Setup

Enter *Program mode* then scroll through the menu categories using the **P**, **^** or **v** keys until you reach the display,

PRESS E TO SET
MEMORY DATA LOG

Press **E** to see the setup selection display, press **^** or **v** repeatedly until you reach the display,

SETUP: TESTS
NEXT CHOICE ^v

Press **E** to accept the selection. Select the Tests log to ON in the next display,

TESTS LOG: ON
^=ON v=OFF

Press **E** to accept. Enter the number of test identification (test ID) in the next display,

ENTER NUMBER OF
TEST ID: 10

Enter the number of test ID. The number of test ID is inversely proportional to the number of Test sample that can be save within a test ID. For example, if the Trend log uses 50 % of the total memory (750 samples). The total memory allocated for the test log is also 750 samples. If the number of test ID is 1 it can have all the 750 samples storage, if the test ID is 10, then each test ID can have maximum of 75 samples storage, i.e $750/10 = 75$. The next display will show the maximum samples per test ID.

MAX. RECORD PER
TEST ID IS 75

Press **E** or **C** to exit to the top of the menu.

Accessing the Memory Log

This section will discuss how to access the 2440 logs. How to retrieve the data saved in the RAM, how to start the test log data recordings, how to download the log data to the PC using the RS-232 port and how to save the data to the PC's disk. The memory log can be accessed from the program mode under the menu 'PRESS E TO ACCESS MEM LOG'.

Recording Event and Min/Max Data

The event log is automatically active once it is turned ON. Refer to the topic "Event and Min/Max Log Setup". The same with the Min/Max data log. An event record will be stored in the memory every time there is an event occurred. Some of the events are alarms and channel kick-out.

The Min/Max will be updated periodically and maintain a record of the real time minimum and maximum values of the measured variables.

Recording Trend Data

The Trend log is automatically active once it is turned ON. Refer to the topic "Trend Log

Setup". Values of the measured variables are save to the RAM periodically. The interval time between logging is defined on the setup. The logging will continue until it is turn OFF from the setup. The logged data is always the most current. The size of the Trend log depends on what is configured.

Recording Test Data

Before a test samples can be recorded, The Test log should be set up as discussed earlier in the section "Test Log Setup". To start a test log, press **P** to go to the program mode. Enter the user password (123456 default) followed by **E**. Press the **P**, **^** or **v** repeatedly until you reach the display,

**PRESS E TO
ACCESS MEM LOG**

Press **E** to see task selection display, press **^** or **v** repeatedly until you reach the display,

**SELECT TASK ^v
RECORD TEST DATA**

Press **E** and enter the test ID on the next display,

**ENTER THE
TEST ID: 1**

Enter the test ID (integer number) followed by **E**. The test ID is use to identify the test that you are going to perform. Enter the number of samples of the test ID on the next display,

**ENTER THE # OF
TEST DATA: 50**

Enter the desired number of test sample for the test followed by **E**. If the number entered is more than the maximum it will prompt you that the number entered is invalid. Select the data acquisition if manual or automatic on the next display,

**LOG IS AUTO: YES
^=YES v=NO**

Select YES if automatic acquisition or NO, if manual acquisition. Press **E** to accept the selection. If YES is selected, enter the acquisition interval time on the next display,

**ENTER INTERVAL
TIME(S): 5**

Enter the interval time in seconds followed by **E**. The fastest interval time is 1 second and the slowest is 28800 seconds (8 hours). Press **E** to proceed to the record mode display. The record mode display is a display of the measured variables values, i.e, flow rate, velocity and temperature. You can view all this variables using the **^** and **v** arrow keys. Example of the display is shown below.

**1000.00 SCFM
166.000 SFPM**

In this mode, if manual acquisition is selected. You can save the current measurements to the RAM every time by pressing **E**. When the number of samples is satisfied, it will exit to the top of the menu. If automatic acquisition is selected, The current measurements will be save to the RAM every time the interval time is satisfied. You can override also by pressing **E** in this mode. The automatic mode is also active in the Executive, Display, and Help (Executive) modes. It means that you can exit to this mode and go to the Executive, Display, or Help mode and the test is still active, A prompt will be displayed momentarily every time measurements is save to the memory.

Viewing Test Data Logs

The following instructions allow user to view the Test log data from the memory. In addition to the individual test samples, statistical data (average, standard deviation, minimum and maximum values) are also calculated and displayed.

Press **P** to go to the program mode. Enter the user password (123456 default) followed by **E**. Press the **P**, **^** or **v** repeatedly until you reach the display,

**PRESS E TO
ACCESS MEM LOG**

Press **E** to see task selection display, press **^** or **v** repeatedly until you reach the display,

**SELECT TASK ^v
VIEW TEST DATA**

Press **E** and enter the test ID on the next display,

ENTER THE

TEST ID: 1

Enter the test ID of the test log that you like to view followed by **E**. Select the measured variable that you like to view in the next display,

**VIEW: FLOW RATE
NEXT CHOICE ^v**

Select "FLOW RATE" if you like to view the flow rate, "VELOCITY" for velocity or "TEMPERATURE" for the medium temperature. Press **E** to accept the selection. The next display is the average data, which is the average of the samples.

**AVERAGE DATA
1001.00 SCFM**

Press **E** to see the Standard Deviation value of the test log data.

**STD. DEVIATION
0.001234 SCFM**

Press **E** to see the Maximum value of the test log data.

**MAXIMUM VALUE
1002.00 SCFM**

Press **E** to see the Minimum value of the test log data.

**MINIMUM VALUE
999.000 SCFM**

The next displays are the measured values of the individual samples.

Press **E** to continue viewing.

**ID: 1 REC: 1
1000.00 SCFM**

Continue until the last sample. The **^** or **v** down arrow can be used to scroll back and forth on the test log data. Press **C** to exit to the top of the menu.

Exporting the Memory Log Data to PC

The 2440 memory log data can be exported to a PC using the RS-232 communication port. In order to make this feature work; the PC must have a terminal emulator program like HyperTerminal from Windows Operating System or other third party software. The PC terminal emulation program must be configured to match the communication parameters of the 2440. The communication parameters are

Communication port used by the PC, baud rate (the 2440 default is 9600 baud), Parity (2440 uses No Parity), Number of Data Bits (2440 uses 8 bits), Stop Bits (2440 uses 1 Stop Bit). The 2440 must be configured to standard Terminal echo mode.

To test for proper communication connect a standard 9-Pin to 9-Pin communication cable from the 2440 to the PC communication port. Run the PC terminal emulation program. If communication is established, there will be data displayed on the PC's screen. If nothing is displayed, it could be the terminal echo of the MFT is turned OFF. Press the '+' character on the keyboard of the PC to turn ON the terminal echo of the 2440. If everything is setup correctly, there should be data displayed on the PC's display immediately after sending the '+' character.

Exporting Event log data

Assuming the communication between the 2440 and the PC is established, Press **P** to go to the program mode. Enter the user password (123456 default) followed by **E**. Press the **P**, **^** or **v** repeatedly until you reach the display,

**PRESS E TO
ACCESS MEM LOG**

Press **E** to see task selection display, press **^** or **v** repeatedly until you reach the display,

**SELECT TASK ^v
LOG TO COM PORT**

Press **E** to see the log selection display, press **^** or **v** repeatedly until you reach the display,

**LOG: EVENTS
NEXT CHOICE ^v**

In order to have a clean display of the data on the PC's screen, it is recommended to turn OFF the terminal echo by pressing the '+' character on the keyboard. Press **E** on the prompt to start downloading the Event log data. The data should be displayed on the PC's display. In order to save the data to a computer file, the emulator program should have an option to capture the received data. Refer to the emulation software manual how to do it. Turn On the capture feature of the emulation software and select for ASCII or Text and enter the filename. Perform the previous instructions when you are ready. For example if you are using the Hyper Terminal emulation program. Follow the Instructions below:

1. Click the Start button on the task bar, select Programs, select Accessories, select Hyperterminal then click Hyper Terminal.
2. From Hyper Terminal program window, a dialog box named "Connection Description" will pop up. Enter the filename of the new connection and choose the appropriate icon. Press OK when ready.
3. Another dialog box named "Connect To" will pop up. Select the proper communication port for the connection from the "Connect using:" list box entry. Select COM1, COM2 or COM3 which ever port had the physical connection to the unit. Press OK when ready.
4. Another dialog box named "COM? Properties will pop up. On the "Port Setting" tab, configure the following parameters;
5. Bits Per Second: Select whatever the 2440 is using (default is 9600).

Data Bits: set to 8
Parity: select NONE
Stop Bits: select 1
Flow Control: select NONE

6. Press OK when ready.
7. If every thing is setup correctly, data should be displayed at the PC's display. If not, try to press the '+' character on the keyboard. If there is no data displayed on the PC, check the connection and communication parameters.
8. Save the file for future use. To save the file, click the "File" menu and click the Save button.
9. To capture the data sent to the terminal, click the "Transfer" from the menu bar, click the "Capture Text". Enter the filename on the dialog box then click the "start" button.
10. At this time all the data that is send to the terminal will be save under the entered filename.
11. To stop capturing data, click the "Transfer" from the menu bar, highlight the "Capture Text" and click on "Stop".
12. Make sure to remember which folder the file is saved.
13. You can view the file using the program Wordpad from Windows Operating System.

Exporting Trend log data

Assuming the communication between the 2440 and the PC is established, Press **P** to go to the program mode. Enter the user password (123456 default) followed by **E**. Press the **P**, **^** or **v** repeatedly until you reach the display,

**PRESS E TO
ACCESS MEM LOG**

Press **E** to see task selection display, press **^** or **v** repeatedly until you reach the display,

**SELECT TASK ^v
LOG TO COM PORT**

Press **E** to see the log selection display, press **^** or **v** repeatedly until you reach the display,

**LOG: TRENDS
NEXT CHOICE ^v**

In order to have a clean display of the data on the PC's screen, it is recommended to turn OFF the terminal echo by pressing the '+' character on the keyboard. Press **E** on the prompt to start downloading the Trend log data. To save the data to the disk, refer to the previous topic "Exporting Events Log Data".

Example data captured by HyperTerminal:

```
***PTA TRENDS DATA***
11:12:42 12/21/2000 1223.2592   SCMH  3.656  SMPS  88.8  DEGC
11:12:37 12/21/2000 1190.8132   SCMH  3.559  SMPS  88.5  DEGC
11:12:32 12/21/2000 1089.0428   SCMH  3.255  SMPS  88.2  DEGC
11:12:27 12/21/2000 1143.7328   SCMH  3.418  SMPS  88.4  DEGC
11:12:22 12/21/2000 1154.6937   SCMH  3.451  SMPS  88.4  DEGC
11:12:17 12/21/2000 1065.6346   SCMH  3.185  SMPS  88.6  DEGC
11:12:12 12/21/2000 1029.1471   SCMH  3.076  SMPS  88.5  DEGC
11:12:07 12/21/2000 1129.2159   SCMH  3.375  SMPS  88.3  DEGC
11:12:02 12/21/2000 1044.5355   SCMH  3.122  SMPS  88.2  DEGC
11:11:57 12/21/2000 1073.1272   SCMH  3.207  SMPS  88.3  DEGC
11:11:52 12/21/2000 1147.9923   SCMH  3.431  SMPS  88.5  DEGC
11:11:47 12/21/2000 1219.8428   SCMH  3.646  SMPS  88.8  DEGC
11:11:42 12/21/2000 1099.2528   SCMH  3.286  SMPS  88.4  DEGC
11:11:37 12/21/2000 1062.6186   SCMH  3.176  SMPS  88.6  DEGC
11:11:32 12/21/2000 1022.0935   SCMH  3.055  SMPS  88.5  DEGC
11:11:27 12/21/2000 1063.6230   SCMH  3.179  SMPS  88.3  DEGC
11:11:22 12/21/2000 1044.0204   SCMH  3.120  SMPS  88.6  DEGC
11:11:17 12/21/2000 1077.0090   SCMH  3.219  SMPS  88.5  DEGC
11:11:12 12/21/2000 1098.4888   SCMH  3.283  SMPS  88.7  DEGC
11:11:07 12/21/2000 1108.0636   SCMH  3.312  SMPS  88.4  DEGC
11:11:02 12/21/2000 1101.6533   SCMH  3.293  SMPS  88.3  DEGC
11:10:57 12/21/2000 1058.5018   SCMH  3.164  SMPS  88.2  DEGC
11:10:52 12/21/2000 1133.8459   SCMH  3.389  SMPS  88.5  DEGC
11:10:47 12/21/2000 1184.0063   SCMH  3.539  SMPS  88.4  DEGC
11:10:42 12/21/2000 1194.6218   SCMH  3.571  SMPS  88.4  DEGC
11:10:37 12/21/2000 1111.9736   SCMH  3.324  SMPS  88.9  DEGC
11:10:32 12/21/2000 1139.2562   SCMH  3.405  SMPS  88.6  DEGC
11:10:27 12/21/2000 1154.4842   SCMH  3.451  SMPS  89.2  DEGC
11:10:22 12/21/2000 1115.0436   SCMH  3.333  SMPS  88.8  DEGC
11:10:17 12/21/2000 1119.6848   SCMH  3.347  SMPS  89.0  DEGC
11:10:12 12/21/2000 1154.7971   SCMH  3.452  SMPS  88.9  DEGC
```

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11:10:07	12/21/2000	1059.6281	SCMH	3.167	SMPS	88.9	DEGC
11:10:02	12/21/2000	1091.9654	SCMH	3.264	SMPS	88.5	DEGC
11:09:57	12/21/2000	1098.2934	SCMH	3.283	SMPS	88.3	DEGC
11:09:52	12/21/2000	1112.7392	SCMH	3.326	SMPS	88.8	DEGC
11:09:47	12/21/2000	1190.3988	SCMH	3.558	SMPS	88.8	DEGC
11:09:42	12/21/2000	1173.9438	SCMH	3.509	SMPS	89.1	DEGC
11:09:37	12/21/2000	1141.2003	SCMH	3.411	SMPS	89.0	DEGC
11:09:32	12/21/2000	1076.3145	SCMH	3.217	SMPS	89.2	DEGC
11:09:27	12/21/2000	1022.4020	SCMH	3.056	SMPS	88.8	DEGC
11:09:22	12/21/2000	1010.1516	SCMH	3.019	SMPS	88.8	DEGC
11:09:17	12/21/2000	959.9527	SCMH	2.869	SMPS	88.9	DEGC
11:09:12	12/21/2000	1118.7978	SCMH	3.344	SMPS	88.7	DEGC
11:09:07	12/21/2000	1219.0290	SCMH	3.644	SMPS	89.1	DEGC
11:09:02	12/21/2000	1146.2478	SCMH	3.426	SMPS	88.9	DEGC
11:08:57	12/21/2000	1225.7136	SCMH	3.664	SMPS	88.4	DEGC
11:08:52	12/21/2000	1065.7784	SCMH	3.185	SMPS	88.3	DEGC
11:08:47	12/21/2000	1075.4364	SCMH	3.214	SMPS	88.7	DEGC
11:08:42	12/21/2000	1211.7534	SCMH	3.622	SMPS	88.6	DEGC
11:08:37	12/21/2000	1118.8799	SCMH	3.344	SMPS	88.4	DEGC
11:08:32	12/21/2000	1194.9697	SCMH	3.572	SMPS	88.6	DEGC
11:08:27	12/21/2000	1133.6325	SCMH	3.388	SMPS	88.4	DEGC
11:08:22	12/21/2000	1012.6558	SCMH	3.027	SMPS	87.9	DEGC
11:08:17	12/21/2000	1190.8711	SCMH	3.559	SMPS	87.8	DEGC
11:08:12	12/21/2000	1087.3918	SCMH	3.250	SMPS	87.6	DEGC
11:08:07	12/21/2000	1138.3967	SCMH	3.403	SMPS	86.9	DEGC
11:08:02	12/21/2000	1155.0944	SCMH	3.452	SMPS	87.6	DEGC
11:07:57	12/21/2000	1290.0501	SCMH	3.856	SMPS	87.4	DEGC
11:07:52	12/21/2000	1261.5849	SCMH	3.771	SMPS	87.2	DEGC
11:07:47	12/21/2000	1149.4514	SCMH	3.436	SMPS	87.9	DEGC
11:07:42	12/21/2000	1165.5301	SCMH	3.484	SMPS	88.3	DEGC
11:07:37	12/21/2000	1246.8624	SCMH	3.727	SMPS	88.6	DEGC
11:07:32	12/21/2000	1128.3254	SCMH	3.372	SMPS	88.4	DEGC
11:07:27	12/21/2000	1117.1947	SCMH	3.339	SMPS	88.7	DEGC
11:07:22	12/21/2000	1112.4036	SCMH	3.325	SMPS	88.7	DEGC
11:07:17	12/21/2000	1167.3924	SCMH	3.489	SMPS	89.3	DEGC
11:07:12	12/21/2000	1205.3096	SCMH	3.603	SMPS	89.5	DEGC
11:07:07	12/21/2000	1085.7400	SCMH	3.245	SMPS	89.3	DEGC
11:07:02	12/21/2000	985.9468	SCMH	2.947	SMPS	88.9	DEGC
11:06:57	12/21/2000	1092.9784	SCMH	3.267	SMPS	89.1	DEGC
11:06:52	12/21/2000	1086.9941	SCMH	3.249	SMPS	88.8	DEGC
11:06:47	12/21/2000	1001.2045	SCMH	2.992	SMPS	88.8	DEGC
11:06:42	12/21/2000	1050.5593	SCMH	3.140	SMPS	88.7	DEGC
11:06:37	12/21/2000	1059.7761	SCMH	3.168	SMPS	88.2	DEGC

TRENDS LOG STATISTICAL DATA

FLOW RATE:

Average: 1111.273520 SCMH

Min: 860.394720 SCMH Max: 1311.521520 SCMH

Standard Deviation: 69.042648 SCMH

VELOCITY:

Average: 3.321470 SMPS

Min: 2.571623 SMPS Max: 3.919990 SMPS

Standard Deviation: 0.206360 SMPS

TEMPERATURE:

Average: 88.494832 DEGC

Min: 86.934072 DEGC Max: 89.484880 DEGC

Standard Deviation: 0.384480 DEGC

SELECT TASK ^v LOG TO COM PORT

SELECT TASK ^v LOG TO COM PORT

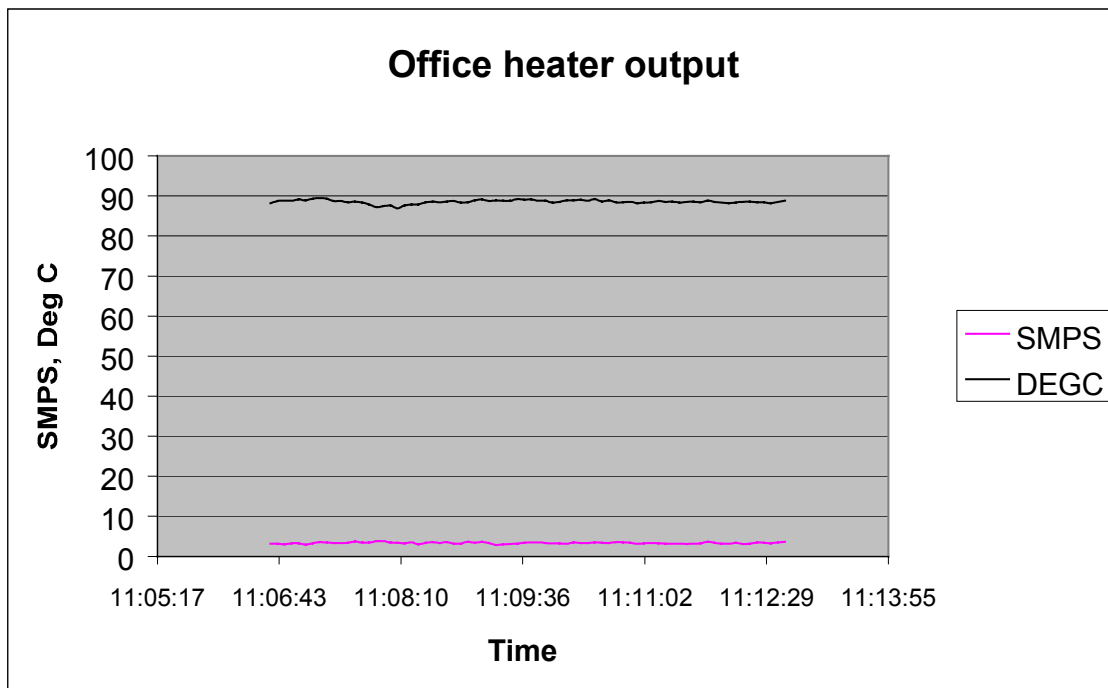
Notice that the newest data came out of the memory first. The first data recorded is the first to leave the 2440 memory window, this works like an oscilloscope or trend plot. We can see the log interval was set for 5 seconds. After the data we see the statistics:

average, min/max and STD for each variable, flow, velocity and temperature. The statistics apply for the whole trend interval. Unless your process has been steady state, these numbers will be useless. After you transfer the data, it clears the trend memory and will start a new capture.

At the very end, HyperTerminal captured the 2440 screen echo after it transferred the data file. This is easily deleted by a word processor before importing to a spreadsheet or with in the spreadsheet.

Importing Trend Data to Excel

Importing this data file to Excel and making an X-Y graph we generated the following trend graph. While there are many steps to do this, the outline is the following: From Excel you open the *.txt file (from Hyper Terminal that you captured) then select spaces as the delimiter. You trim off the extra text records and hide the columns you do not want. Only the time, velocity and temperature were used in this case.



This trend plot was a measurement of an office electric heater. We see the temperature typically about 88° C and the velocity about 3 SMPS during the six-minute data capture shown.

Exporting Test log data

Assuming the communication between the 2440 and the PC is established, Press **P** to go to the program mode. Enter the user password (123456 default) followed by **E**. Press the **P**, **^** or **v** repeatedly until you reach the display,

**PRESS E TO
ACCESS MEM LOG**

Press **E** to see task selection display, press **^** or **v** repeatedly until you reach the display,

**SELECT TASK ^v
LOG TO COM PORT**

Press **E** to see the log selection display, press **^** or **v** repeatedly until you reach the display,

**LOG: TESTS
NEXT CHOICE ^v**

Press **E** and enter the ID of the test log data that you want to export on the next display,

**PRESS E TO START
LOG TEST ID: 1**

In order to have a clean display of the data on the PC's screen, it is recommended to turn OFF the terminal echo by pressing the '+' character on the keyboard. Enter the test ID followed by **E** to start downloading the Test log data. To save the data to the disk, refer to the previous topic "Exporting Event Log Data".

An example data capture from the test-set memory with HyperTerminal:

```
***PTA TESTS DATA***
***TEST SET #1 DATA***
16:37:48 12/13/2000 82.5096      SCMH  0.247  SMPS  29.5  DEGC
16:37:58 12/13/2000 411.1208     SCMH  1.229  SMPS  28.1  DEGC
16:38:04 12/13/2000 250.4319     SCMH  0.749  SMPS  27.8  DEGC
16:38:06 12/13/2000 408.2584     SCMH  1.220  SMPS  27.3  DEGC
16:38:08 12/13/2000 434.2441     SCMH  1.298  SMPS  27.5  DEGC
16:38:10 12/13/2000 415.0828     SCMH  1.241  SMPS  27.0  DEGC
16:38:12 12/13/2000 440.2772     SCMH  1.316  SMPS  27.1  DEGC
16:38:14 12/13/2000 449.9151     SCMH  1.345  SMPS  27.4  DEGC
16:38:16 12/13/2000 444.1419     SCMH  1.327  SMPS  26.5  DEGC
16:38:18 12/13/2000 465.1257     SCMH  1.390  SMPS  26.9  DEGC
***TEST SET #1 STATISTICAL DATA***
FLOW RATE:
Average: 380.110760 SCMH
Min: 82.509600 SCMH  Max: 465.125720 SCMH
```

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Standard Deviation: 120.697328 SCMH

VELOCITY:

Average: 1.136109 SMPS

Min: 0.246612 SMPS Max: 1.390209 SMPS

Standard Deviation: 0.360750 SMPS

TEMPERATURE:

Average: 27.515102 DEGC

Min: 26.518276 DEGC Max: 29.530868 DEGC

Standard Deviation: 0.850275 DEGC

TEST SET #2 DATA

17:41:47	12/20/2000	746.9471	SCMH	2.233	SMPS	30.2	DEGC
17:41:48	12/20/2000	774.3063	SCMH	2.314	SMPS	30.0	DEGC
17:41:50	12/20/2000	775.1250	SCMH	2.317	SMPS	30.0	DEGC
17:41:51	12/20/2000	756.0284	SCMH	2.260	SMPS	30.2	DEGC
17:41:54	12/20/2000	730.7208	SCMH	2.184	SMPS	30.1	DEGC
17:41:55	12/20/2000	746.3576	SCMH	2.231	SMPS	29.0	DEGC
17:41:58	12/20/2000	783.3466	SCMH	2.341	SMPS	29.0	DEGC
17:42:02	12/20/2000	783.6123	SCMH	2.342	SMPS	28.1	DEGC
17:42:09	12/20/2000	720.7290	SCMH	2.154	SMPS	28.1	DEGC
17:42:10	12/20/2000	723.7121	SCMH	2.163	SMPS	28.0	DEGC
17:42:13	12/20/2000	781.7126	SCMH	2.336	SMPS	27.2	DEGC
17:42:16	12/20/2000	737.9092	SCMH	2.206	SMPS	27.1	DEGC
17:42:18	12/20/2000	737.0017	SCMH	2.203	SMPS	27.0	DEGC
17:42:20	12/20/2000	694.9312	SCMH	2.077	SMPS	27.9	DEGC
17:42:21	12/20/2000	710.3100	SCMH	2.123	SMPS	27.3	DEGC
17:42:26	12/20/2000	673.4567	SCMH	2.013	SMPS	27.2	DEGC
17:42:28	12/20/2000	699.8013	SCMH	2.092	SMPS	27.0	DEGC
17:42:29	12/20/2000	696.0386	SCMH	2.080	SMPS	26.4	DEGC
17:42:37	12/20/2000	730.9830	SCMH	2.185	SMPS	26.8	DEGC
17:42:38	12/20/2000	732.6891	SCMH	2.190	SMPS	26.6	DEGC
17:42:39	12/20/2000	729.6077	SCMH	2.181	SMPS	27.1	DEGC
17:42:40	12/20/2000	718.2977	SCMH	2.147	SMPS	27.0	DEGC
17:42:41	12/20/2000	718.2366	SCMH	2.147	SMPS	26.8	DEGC
17:42:42	12/20/2000	701.7817	SCMH	2.098	SMPS	26.6	DEGC
17:42:43	12/20/2000	677.6675	SCMH	2.025	SMPS	26.8	DEGC

TEST SET #2 STATISTICAL DATA

FLOW RATE:

Average: 731.252480 SCMH

Min: 673.456720 SCMH Max: 783.612320 SCMH

Standard Deviation: 31.965418 SCMH

VELOCITY:

Average: 2.185632 SMPS

Min: 2.012887 SMPS Max: 2.342130 SMPS

Standard Deviation: 0.095541 SMPS

TEMPERATURE:

Average: 27.900048 DEGC

Min: 26.414518 DEGC Max: 30.238298 DEGC

Standard Deviation: 1.312100 DEGC

TEST SET #3 DATA

Test Set #3 has no record.

TEST SET #4 DATA

Test Set #4 has no record.

TEST SET #5 DATA

Test Set #5 has no record.

TEST SET #6 DATA

Test Set #6 has no record.

TEST SET #7 DATA

Test Set #7 has no record.

TEST SET #8 DATA

Test Set #8 has no record.

TEST SET #9 DATA

Test Set #9 has no record.

TEST SET #10 DATA

Test Set #10 has no record.

SELECT TASK ^v LOG TO COM PORT

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```
SELECT TASK ^v LOG TO COM PORT
SELECT TASK ^v LOG TO COM PORT
```

Here we see data for 10 test-sets. Test-set 1 has 10 data points and its summary data. Test-set 2 has 25 points and its summary data with all other test-sets 3 to 10 empty. In this example, the memory had 50% to trend or 750 records available for test-sets and since there were 10 sets, each had a maximum of 75 points. Once again, at the very end, we see the scroll captured by HyperTerminal after the data was captured.

The same data imported into Excel using the space as a delimiter looks like this:

PTA	TESTS	DATA					
TEST	SET	#1	DATA				
16:37:48	12/13/00	82.5096	SCMH	0.247	SMPS	29.5	DEGC
16:37:58	12/13/00	411.1208	SCMH	1.229	SMPS	28.1	DEGC
16:38:04	12/13/00	250.4319	SCMH	0.749	SMPS	27.8	DEGC
16:38:06	12/13/00	408.2584	SCMH	1.22	SMPS	27.3	DEGC
16:38:08	12/13/00	434.2441	SCMH	1.298	SMPS	27.5	DEGC
16:38:10	12/13/00	415.0828	SCMH	1.241	SMPS	27	DEGC
16:38:12	12/13/00	440.2772	SCMH	1.316	SMPS	27.1	DEGC
16:38:14	12/13/00	449.9151	SCMH	1.345	SMPS	27.4	DEGC
16:38:16	12/13/00	444.1419	SCMH	1.327	SMPS	26.5	DEGC
16:38:18	12/13/00	465.1257	SCMH	1.39	SMPS	26.9	DEGC
TEST	SET	#1	STATISTICAL	DATA			
FLOW	RATE:						
Average:	380.11076	SCMH					
Min:	82.5096	SCMH	Max:	465.12572	SCMH		
Standard	Deviation:	120.69733	SCMH				
VELOCITY:							
Average:	1/13/09	SMPS					
Min:	0.246612	SMPS	Max:	1.390209	SMPS		
Standard	Deviation:	0.36075	SMPS				
TEMPERATURE:							
Average:	27.515102	DEGC					
Min:	26.518276	DEGC	Max:	29.530868	DEGC		
Standard	Deviation:	0.850275	DEGC				
TEST	SET	#2	DATA				
17:41:47	12/20/00	746.9471	SCMH	2.233	SMPS	30.2	DEGC
17:41:48	12/20/00	774.3063	SCMH	2.314	SMPS	30	DEGC
17:41:50	12/20/00	775.125	SCMH	2.317	SMPS	30	DEGC
17:41:51	12/20/00	756.0284	SCMH	2.26	SMPS	30.2	DEGC
17:41:54	12/20/00	730.7208	SCMH	2.184	SMPS	30.1	DEGC

17:41:55	12/20/00	746.3576	SCMH	2.231	SMPS	29	DEGC
17:41:58	12/20/00	783.3466	SCMH	2.341	SMPS	29	DEGC
17:42:02	12/20/00	783.6123	SCMH	2.342	SMPS	28.1	DEGC
17:42:09	12/20/00	720.729	SCMH	2.154	SMPS	28.1	DEGC
17:42:10	12/20/00	723.7121	SCMH	2.163	SMPS	28	DEGC
17:42:13	12/20/00	781.7126	SCMH	2.336	SMPS	27.2	DEGC
17:42:16	12/20/00	737.9092	SCMH	2.206	SMPS	27.1	DEGC
17:42:18	12/20/00	737.0017	SCMH	2.203	SMPS	27	DEGC
17:42:20	12/20/00	694.9312	SCMH	2.077	SMPS	27.9	DEGC
17:42:21	12/20/00	710.31	SCMH	2.123	SMPS	27.3	DEGC
17:42:26	12/20/00	673.4567	SCMH	2.013	SMPS	27.2	DEGC
17:42:28	12/20/00	699.8013	SCMH	2.092	SMPS	27	DEGC
17:42:29	12/20/00	696.0386	SCMH	2.08	SMPS	26.4	DEGC
17:42:37	12/20/00	730.983	SCMH	2.185	SMPS	26.8	DEGC
17:42:38	12/20/00	732.6891	SCMH	2.19	SMPS	26.6	DEGC
17:42:39	12/20/00	729.6077	SCMH	2.181	SMPS	27.1	DEGC
17:42:40	12/20/00	718.2977	SCMH	2.147	SMPS	27	DEGC
17:42:41	12/20/00	718.2366	SCMH	2.147	SMPS	26.8	DEGC
17:42:42	12/20/00	701.7817	SCMH	2.098	SMPS	26.6	DEGC
17:42:43	12/20/00	677.6675	SCMH	2.025	SMPS	26.8	DEGC
TEST	SET	#2	STATISTICAL	DATA			
FLOW	RATE:						
Average:	731.25248	SCMH					
Min:	673.45672	SCMH	Max:	783.61232	SCMH		
Standard	Deviation:	31.965418	SCMH				
VELOCITY:							
Average:	2/18/32	SMPS					
Min:	2/1/87	SMPS	Max:	2.34213	SMPS		
Standard	Deviation:	0.095541	SMPS				
TEMPERATURE:							
Average:	27.900048	DEGC					
Min:	26.414518	DEGC	Max:	30.238298	DEGC		
Standard	Deviation:	1.3121	DEGC				
TEST	SET	#3	DATA				
Test	Set	#3	has	no	record.		
TEST	SET	#4	DATA				
Test	Set	#4	has	no	record.		
TEST	SET	#5	DATA				
Test	Set	#5	has	no	record.		
TEST	SET	#6	DATA				
Test	Set	#6	has	no	record.		
TEST	SET	#7	DATA				

Test	Set	#7	has	no	record.		
TEST	SET	#8	DATA				
Test	Set	#8	has	no	record.		
TEST	SET	#9	DATA				
Test	Set	#9	has	no	record.		
TEST	SET	#10	DATA				
Test	Set	#10	has	no	record.		
SELECT	TASK	^v	LOG	TO	COM	PORT	
SELECT	TASK	^v	LOG	TO	COM	PORT	
SELECT	TASK	^v	LOG	TO	COM	PORT	

You can trim the extra records you do not want and could graph the results if you like. Not that each text item from the *.txt file captured in Hyper Terminal ended up in its own cell because the "space" was used as the field delimiter when the file was imported to Excel.

Flow Calibration

Calibration of the 2440

The basic flow element calibration is done at the Factory but can be redone at any flow calibration lab. This data is standard velocity for insertion flow elements and standard volumetric flow or mass flow for in-line flow elements.

The 2440 velocity calibration data is stored on an EEPROM but can be user modified using the correction factors under *Program mode*. You can also change the reference conditions or units of the displayed data in *Program mode*.

It is important to know that the unit is sold with non-hazardous gas calibrations only. (Air, O₂, N₂, Ar, CO₂, He). In general, the heat transfer for cooling effect measured with the thermal anemometer scales with the molecular weight of the gas and is strongly affected by the number of hydrogen atoms hanging off the molecule. While any gas can be measured with the device, we do not offer calibrations of the other gases as the safety approvals are not possible with the Series 2440 for hazardous gases. The Kurz 490 has an intrinsically safe approval calibrated for Air and could be used in any gas. See our website for more info.

Using the 2440 for Field Calibration

Field calibration process permits a system to not only have a repeatable reading but absolute accuracy. Two popular field calibration procedures at Kurz are:

- Velocity Traverse and
- Tracer Gas Dilution

The traverse is a classic method and has been documented by many standards organizations and a summary can be found in Appendix H. This summary applies to both round and rectangular ducts.

The tracer gas method is not as common but has many advantages:

- Independent of flow measurement technology to thermal or differential pressure,
- Insensitive to flow profiles,
- Insensitive to process pressure and temperature,
- Insensitive to many process fluid mixtures or variations in such.

The only down side for the tracer method is the special equipment needed to perform it. You can find more on the tracer gas method at our website under Technical Paper 364011.

A Kurz thermal anemometer system will provide a repeatable reading if properly installed for the specific application without the field calibration. If accuracy is needed, then the field calibration is required.

Troubleshooting

The following chart shows some of the most common issues and some proposed corrective actions

TROUBLESHOOTING CHART	
Symptom	Possible Reasons
Unit will not turn on	Dead Battery, plug in charger then turn on after if has partly recharged to check. Battery Removed?
Unit turns off by itself	This is normal when the battery is discharged. Recharge to fix this.
Charge light will not turn on when I plug in charger.	Battery too hot or too cold (battery must be 0 to 50° C)
Backlight turns on but no characters	LCD contrast is not properly adjusted. Set R16 inside the front panel for best viewing
Characters are hard to read, with or without the backlight.	LCD contrast is not properly adjusted. Set R16 inside the front panel for best viewing
Flow reads a large negative number and so does the temperature or it says "TEMP NOTAVILABLE"	Sensor not plugged in.
Unit says "TEMP NOT AVAILABLE"	This is normal at low velocity so you do not see a false high temperature reading. The trip point is programmable.
Units says "SERIAL NUMBERS DON'T MATCH"	If the battery backed up memory has been corrupted and it lost its data you will see this screen. You press enter to re-load the data from both the sensor and 4-20 mA board and it will continue working. If the same errors re-appear, you may need to completely erase the RAM by shorting TP2 to ground when the power is off then try again. Check lithium cell for voltage above 2.5 V (top of cell to ground)
Display says "KURZ INSTRUMENTS DISPLAY DRIVER 1.0"	This is a normal temporary screen during boot up. If it stays on, then the CPU is not communicating with the display circuit. Send the flow meter back to Kurz for service.

4-20 mA does not change with flow	Are you connected to the proper output channel? What is your output range? Did you remove the sensor cover? Defective Sensor or electronics
4-20 mA saturates before full scale	Check the range.
No RS-232 or RS-485 signal	Check the 15 conductor cable to the I/O adapter and the jumper/shut which selects the serial port for 232/485

Return Shipment

RMA (Return Material Authorization) Number

If you believe your unit is not working properly, contact the Kurz Customer Service Department at: (831) 646-5911 or send E-mail to service@kurz-instruments.com . Please have the following information ready to give to the Kurz Customer Service Representative :

- Defective unit's model number and serial number,
- Detailed description of application and type of environment unit is being used in,
- Detailed description of perceived problem,
- Type of gas, Flow range, and standard conditions unit is to be recalibrated at,
- Any special QA requirements (nuclear or military application, oxygen service, special calibration or certification etc),
- Technical contact's name and phone number,
- Billing contact's name and phone number,
- Complete shipping address,
- Complete billing address.

You will then be issued an RMA number. **Kurz personnel will refuse to accept return material shipments if an RMA number is not visible on the outside surface of the shipping container.**

Cleaning of Material to be Returned

Thoroughly clean all material to be returned to Kurz. Because we serve a diverse customer base, there is a risk of receiving contaminated returned material from our customers. **When uncleaned material is received at Kurz, the customer will be contacted to arrange at their expense for the material to be picked up from Kurz**

and cleaned before Kurz personnel handle the equipment.

Shipping Material to be Returned

Securely package cleaned material **(When uncleaned material is received at Kurz, the customer will be contacted to arrange at their expense for the material to be picked up from Kurz and cleaned before Kurz personnel handle the equipment)** along with a packing slip referencing the RMA number, model number and serial number in a sturdy container with the return address and RMA number clearly marked on the outside surface of the container. **Kurz personnel will refuse to accept return material shipments if an RMA number is not visible on the outside surface of the shipping container.**

Ship pre-paid to the following address:

KURZ INSTRUMENTS INC
CUSTOMER SERVICE DEPT
2411 GARDEN RD
MONTEREY CA 93940-5394
USA

GLOSSARY

ASCII The is the American Standard Character Information Interchange binary code for characters. It is also a version of the Modbus protocol that uses hex-decimal character representation of the RTU format, for two bytes per one used with the RTU.

CORRECTION FACTOR: For insertion flow transmitters this is a number typically between 0.7 and 1.0 needed to convert a point velocity reading to the true duct average. This number is velocity or flow rate dependent. It can also be used to trim an in-line flow transmitter but the numbers are much closer to unity since the velocity profile information is built into the calibration.

DEGC: Degrees Celsius.

DEGF: Degrees Fahrenheit.

DISPLAY MODE: The set of display menus for viewing the meter readings.

EEPROM: Nonvolatile solid state memory device.

EXECUTIVE MODE: This is the menu-state the flow meter starts in. You branch to Display Mode, Program Mode or can view the meter summaries from their scroll.

FLASH MEMORY: Nonvolatile reprogrammable solid state memory device used for program memory.

KGH: Kilograms-per-Hour

KGM: Kilograms-per-Minute

L/D: This is the Length to Diameter ratio in a pipe or duct between two locations. This non dimensional parameter is a comparative metric used to measure the distance between a flow disturbance and a measurement point. Both upstream, and downstream values are needed to quantify an installation.

LCD: Liquid Crystal Display. A 2 line by 16 character, back-lit display is used on the Series 2440 for visibility in dark areas.

MASS FLOW: Mass per unit time (i.e. Kg/s). This is the standard volumetric flow multiplied by the standard density.

MENU CATEGORY: The top level screens within program or display mode are menu categories.

MENU SCREEN: Any screen where data is presented or can be changed. Menu screens are found within or under the menu categories.

MENU-STATE: A viewing or display screen of the LCD. See drawing in the Appendix for a comprehensive listing of the menu-states.

METER: A virtual single task device which measures an engineering value and may totalize its rate.

PARSE: This is the text processing algorithm required to separate data values from a string of data.

PLC Programmable Logic Controller. These dedicated computers are configured to do a task and can read/write data to digital and analog devices.

PPH: Pounds-per-Hour.

PPM: Pounds-per-Minute.

PROFILE: See Velocity Profile.

PROGRAM MODE: The set of display menus for programming or configuring the meter.

PSIA: Pounds per Square Inch, Absolute pressure reference.

REBOOT: When a computer restarts there is a delay from the power on until it is operating normally. During this time it is loading its programs, doing some testing and initializing things. For the Series MFT this takes about seven seconds.

RTU: This is the Remote Terminal Unit Modbus protocol. It is a binary formatted data packet with address, command data packet size and data. See the <http://www.modicon.com/> website for the on line version of the specification, PI-MBUS-300

SBCF: Sensor Blockage Correction Factor. This is the geometric projection of the sensor element and probe support area subtracted from the duct area, this quantity normalized by the duct area.

SCFH: Standard Cubic Feet-per-Hour.

SCFM: Standard Cubic Feet-per-Minute.

SCMH: Standard Cubic Meters-per-Hour.

SCMM: Standard Cubic Meters-per-Minute.

SCMS: Standard Cubic Meters-per-Second.

SFPM: Standard Feet-per-Minute.

SMPS: Standard Meters-per-Second.

SPECIFIC HUMIDITY: The absolute ratio of water mass to dry Air mass is the specific humidity ω . The saturation point of water vapor in Air is temperature dependent. The percentage water vapor compared to the saturation point is known as relative humidity given in a percentage by the weather forecasters.

STANDARD VELOCITY: is the ρv product normalized to a standard density.

Standard Velocity = $\rho v / \rho_s$ with units of velocity

where ρ is the actual density, v is the actual velocity and ρ_s is the standard gas density. For air this is 0.07387 lb/ft³ at 25 °C and 29.92 in Hg.

STANDARD VOLUMETRIC FLOW: is the ρv product multiplied by an area (like a pipe cross section), normalized to a standard density.

Standard Volumetric Flow = Area x (Standard Velocity)

$$= A\rho v / \rho_s$$

where ρ is the actual density, v is the actual velocity and ρ_s is the standard gas density and A is the area.

VELOCITY PROFILE: Due to drag and viscous fluid flow, the velocity in a duct tends to be its highest in the center and goes to zero at the duct walls. This shape is bullet nose at low velocities known as laminar, and flattens out at the higher more turbulent flow rates. A velocity dependent correction factor is measured based on an in-situ calibration to accurately convert the sensors velocity reading to the true average for computing flow or mass flow.

VTM: Velocity Temperature Mapping. This is a calibration method where data at several temperatures are loaded into the flow meter. Flow signal linearization and then interpolation between the different temperature data sets are performed. This

method is a second order correction to the sensors response and provides a more accurate temperature compensated flow measurement.

Appendix A

Thermal Anemometer Measurements

The Kurz thermal anemometers use two RTDs, one heated 50 to 100 °C above the ambient, the other monitors the ambient. The current required to keep the velocity element heated is the parameter calibrated in our wind tunnels.

Mass Rate

What does a thermal flow sensor measure? Because of the equations of forced convective heat transfer, the output of any thermal anemometer is proportional to the sensor's Reynolds number (Re). Looking at the Reynolds number we can see how it measures mass rate per unit area, NOT volumetric flow rate. Therefore, the thermal anemometer automatically compensates for density.

Because a thermal anemometer measures the unit-area mass flow, it can be said to measure mass rate. In other words, it measures the true velocity, weighted by the density of the flowing gas. If the mass rate is normalized by a known density, it has velocity units, a term known as standard velocity. The next section helps explain where these ideas come from.

Mass Flow Equations

Reynolds Number

Lets look at the Reynolds number since it is proportional to the sensor's power or current when heated X degrees above the ambient:

$$Re = \rho v d / \mu$$

where

ρ = actual density
 v = actual velocity
 d = sensor's diameter

μ = gas viscosity

It is the density and velocity (ρv) product that makes the thermal anemometer a mass flow meter. Density (ρ) has units of mass/volume and velocity (v) has units of length/time. So the ρv product has units of (mass/time)/area or mass rate per unit area.

For example:

ρ is kg/m^3 , v is m/s

so ρv is $(\text{kg/s})/\text{m}^2$

The sensor is sensitive to the energy that the gas molecules hitting it take away in the form of heat. This energy is proportional to the size and number of molecules that hit the sensor. It does not know about density and velocity. Small light gas molecules like hydrogen (H_2) having a large surface area to mass ratio, are more efficient at transferring the vibrational heat energy of the sensor surface than large heavy molecules like Argon (Ar) having a small surface area to mass ratio.

Standard Velocity is the ρv product normalized to a standard density.

$$\text{Standard Velocity} = \rho v / \rho_s$$

where ρ_s is the standard gas density. For air this is 0.07387 lb/ft^3 at 25°C and 29.92 in Hg .

Note: the density units cancel and you are left with velocity (m/s). Typical units are: Standard Feet Per Minute (SFPM) or Standard Meters Per Second (SMPS). If the gas density doubled (you went from 15 PSIA to 30 PSIA) at the same actual velocity, the standard velocity would double. This also means that if the process gas is at the same temperature and pressure as the standard condition or the same density, the standard velocity and actual velocity are identical.

Standard Volumetric Flow is the ρv product multiplied by an area (like a pipe cross section), normalized to a standard density

$$\begin{aligned} \text{Standard Volumetric Flow} &= \text{Area} \times (\text{Standard Velocity}) \\ &= A \rho v / \rho_s \end{aligned}$$

where A is the area:

The units here are volume/time (m^3/s)

Typical Displayed units are:

SCFM, Standard Cubic Feet-per-Minute

SCMM, Standard Cubic Meters-per-Minute

SCFH, Standard Cubic Feet-per-Hour
SCMH, Standard Cubic Meters-per-Hour

Mass Flow is obtained by simply multiplying the Standard Volumetric Flow by the Standard Density.

$$\text{Mass Flow} = (\text{Standard Volumetric Flow}) \times \rho_s \\ = A\rho v$$

The units here are mass/time (kg/s)

Typical units are:

PPH, Pounds-per-Hour

KGH, Kilograms-per-Hour

Different gases have different standard densities. This is often described as a reference density (air) multiplied by a specific gravity (sg).

$$\rho_s = \rho_{\text{air}} \text{sg}$$

Then:

$$\text{Mass Flow} = (\text{Standard Volumetric Flow}) \times \rho_{\text{air}} \text{sg} \\ = A(v\rho/\rho_s) \rho_{\text{air}} \text{sg}$$

Conversion of Standard Velocity or Standard Volumetric Flow to actual requires only scaling the result for the gas density according to the ideal gas law.

$$V_a = V_s (P_s/P_a)(T_a/T_s)$$

or

$$F_a = F_s (P_s/P_a)(T_a/T_s)$$

where

V_a is actual velocity, V_s is standard velocity

F_a is actual volumetric flow, F_s is standard volumetric flow

P_s is the standard pressure in absolute units

P_a is the actual pressure in absolute units

T_a is the actual temperature in absolute units (Kelvin or Rankin)

T_s is the standard temperature in absolute units (Kelvin or Rankin)

Note: °K = °C + 273.16, °R = °F + 459.67

Gas Property Induced Errors

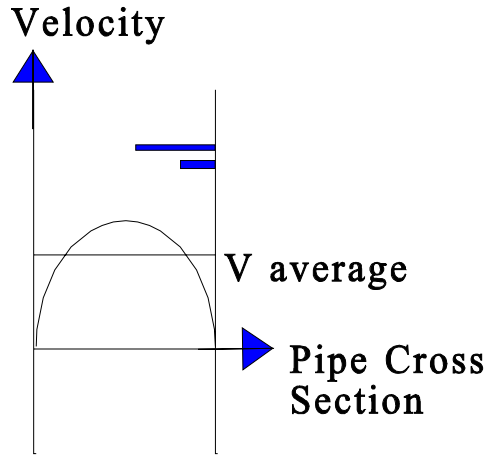
There are secondary effects which cause mistracking of the idea thermal anemometer.

- Pressure changes will affect the calibration for some gasses. For example, N₂ has a large 2.5% /100 psi shift in its viscosity which changes its mass flow reading the same amount. By contrast He has nearly no viscosity change with pressure.
- Temperature changes will affect the gas thermal conductivity and viscosity so the calibration will drift. This is typically 2.5% /100 °C. The minimum drift occurs near 3000 SFPM where the dynamic temperature compensation is performed.
- Temperature profiles in the pipe will produce flow errors. This is caused by using uninsulated pipe upstream of the sensor where the gas is above or below the ambient temperature.
- Low flow free convective heat transfer forces compete with forced convective and conductive heat transfer forces for power. This causes measurable errors (depending on gas type, temperature, pressure, and orientation of sensor to both flow and gravity) starting at about 300 SFPM and becomes significant down at about 100 SFPM.
- Wet vs. Dry Flow Rate: The thermal anemometer responds to all gas molecules which hit it. In the case of water vapor(H₂O) dissolved in Air, it reads what is know as wet standard volumetric flow or WSCFM. For intake combustion processes you want to know the dry standard volumetric flow or DSCFM which is 21% O₂ so your fuel air ratio can be properly computed. Knowing the specific humidity ratio ω you can use the following equation up to 5% ω and get results within 1%:

$$\text{DSCFM} = \text{WSCFM} \times 0.622 / (0.622 + \omega)$$

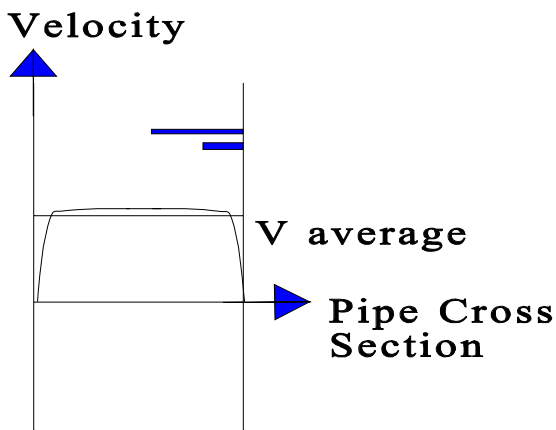
For example. In Monterey California, a typical dew point of 14° C corresponds to 70 grains/lb of Air based on the Psychrometric chart. Since there are 7000 grains per pound this is 1% specific humidity ($\omega = 0.01$). Therefore $\text{DSCFM} = \text{WSCFM} \times 0.622 / (0.622 + 0.01) = \text{WSCFM} \times 0.984$. In other words, 1.6% if the Air by volume is water vapor. See the Kurz technical note on our web-site for a derivation of the above equation.

Flow Profiles And Correction Factors.



Low Velocity (Reynolds Number) Laminar Profile

At low velocity, a laminar velocity profile develops across the pipe cross section as shown in the figure. Note that the peak velocity is about 30% higher than the velocity average (V_{average}). At higher flow rates, a flatter velocity profile develops where the peak velocity is closer to the average. So depending on where the sensor is located, it will read a different fraction of the average velocity. It is the average velocity multiplied by the cross sectional area that will obtain the total flow.

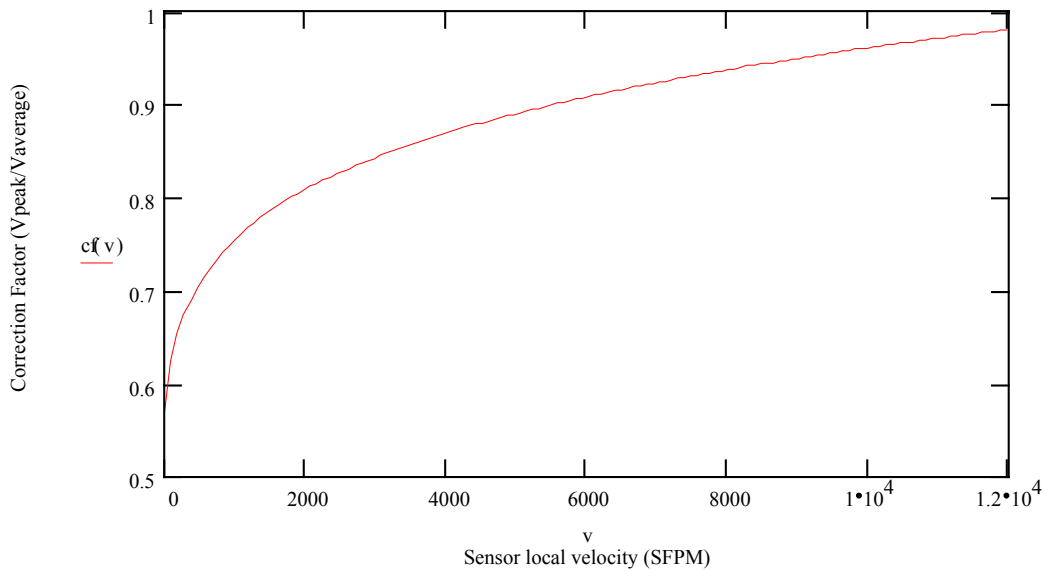


High Velocity (Reynolds Number) Turbulent Profile

Correction Factors

The use of a velocity dependent correction factor can convert the local velocity measurement to average velocity.

$$\text{Flow} = V_{\text{local}} * \text{Area} * \text{cf}(V_{\text{local}})$$



The above correction factor curve was measured from a 4" ID pipe with a 2" welded support, triple sting CD sensor. For other sized ducts, the data can be scaled by the Reynolds Number.

Use Of The Flow Equations In The Kurz Mass Flow Computer

Single Point Insertion Flow Elements like the 410, 450, 452 and 454FT flow transmitter are calibrated as velocity devices in gas X. You can display standard velocity, or with application specific information you can display standard volumetric flow and mass flow:

- Area,
- Sensor and probe support blockage
- Correction factor (velocity profile)
- Gas specific gravity when reading mass flow

Multi-point Insertion Flow Elements (K-BAR) are also calibrated as a velocity devices in gas X. You can display standard velocity or with application specific information you can display standard volumetric flow and mass flow:

Area

Sensor and probe support blockage

Correction factor (velocity profile). This tends to be automatic since the velocity is measured across the duct at equal area locations.

Gas specific gravity, when reading mass flow.

In-line Flow Elements (510, 502, 522UHP, 532) and the 504FT flow transmitter are calibrated as standard volumetric flow devices in gas X. You can display standard volumetric flow or with application specific information it will display standard velocity or mass flow:

Area,

Sensor and probe support blockage

Correction factor (velocity profile)

Gas specific gravity when reading mass flow

To maintain the Factory calibration on in-line units requires adherence to the recommended L/D upstream and downstream criteria. This ensures the long pipe run velocity profile when used in the field.

Example L/D criteria:

Model 502-16

L/D is from the heated sensor to the disturbance	90 ° Elbow at x L/D	Calibration Error
	10	11 %
	20	2.5 %
	30	< 0.5 %

These lengths are reduced significantly [factors of 16, area-ratio². Area-ratio = Free pipe area/(venturi throat area)] for flow elements and transmitters that have a venturi flow conditioner like the 542 or 544FT.

Problems:

Air flow of 100,000 lb/hr through a 3' x 3' square duct, 901F, 20 PSIG

- a. What is mass flow in SCFM _____
- b. What is velocity in SFPM _____
- c. The actual velocity is _____
- d. What range does Kurz calibrate to _____

Nitrogen flow of 10 ACFM through a 3" Schedule 40 pipe, 1101F, 50 PSIG

- e. What is the area _____
- f. What is the flow rate in SCFM _____
- g. The velocity in SFPM is _____
- h. The calibration max. range is _____

Answers on the Next Page:

Worked out answers to the previous questions.

Kurz Standard Reference Conditions.

Air density: 0.0739 lb/ft^3 at $77 \text{ }^\circ\text{F}$ and 14.69 psia ,

a: $100,000 \text{ lb/hr} \times (1 \text{ hr}/60 \text{ min}) \times 1 \text{ ft}^3/0.0739 \text{ lb} = 22,553 \text{ ft}^3/\text{min}$ which is $22,553 \text{ SCFM}$ since our density was at standard conditions.

b: $\text{Velocity} = (\text{Volume rate}) / \text{Area} = 22,553 / (3 \times 3)$
 $= 2506 \text{ SFPM}$.

c: $V_a = V_s (P_s/P_a)(T_a/T_s) = 2506 (14.69/\{20 + 14.69\})(460 + 90)/(460 + 77)$
 $= 1087 \text{ FPM}$.

d: Calibrated rates are about 1.5 times the expected maximum.
So $2506 \text{ SFPM} \times 1.5 \sim 4000 \text{ SFPM}$.

e: ID of schedule 40 3" pipe is $\sim 3"$ $\text{Area} = 3.14 D^2/4$
 $= 3.14(3/12)^2 / 4 = 0.0491 \text{ ft}^2$.

f: Same as C above but the other way around with flow.
 $F_s = F_a(P_a/P_s)(T_s/T_a) = 10 (50 + 14.69)/14.69 (460 + 77)/(460 + 110)$
 $= 41.49 \text{ SCFM}$.

g: $\text{Volumetric Rate} / \text{Area} = \text{Velocity} = 41.49 \text{ SCFM} / 0.0491 \text{ ft}^2$
 $= 845 \text{ SFPM}$.

h: Calibrated rates are about 1.5 times the expected maximum.
So $41.49 \text{ SCFM} \times 1.5 \sim 60 \text{ SCFM}$.

Appendix B

Product Approvals

Series 2440 Declaration of CE Compliance

This is to declare, in accordance with Directive 89/336/EEC for Industrial, Scientific and Medical (ISM) equipment; that Kurz Instruments Series 2440 which comprise the Series 2441, 2442, 2443, 2444 and 2445 Portable Thermal Anemometers have been designed and manufactured in accordance with the EN 50081-1 light industrial emissions standard and the EN 50082-2 heavy industrial immunity standard. The test record for this declaration is Kurz document 430038. This declaration is made on the basis that the above equipment has been designed and manufactured according to the electrical safety principles embodied in the Low Voltage Directive (73/23/EEC) and uses good engineering practice where other aspects of safety are concerned.

Signed: *Jerry L. Kurz*

Date: *12-15-2000*

Name: *Jerome L. Kurz*

Position: *President*

Appendix C

MFTCOMMC Installation and Operation

451017

MFTCOMMC Installation and Operation Guide

Kurz Instruments Inc.

MFTCOMMC Version 1.41

Installation and Operation

Introduction

MFTCOMMC is a Series MFT and PTA configuration upload/download program for Windows with text translators to make printable files. MFTCOMMC version 1.41 will make printable files of MFT 1.0x, 1.1x, 1.2x and 1.3x and PTA 1.0x configuration files.

Installation

System Requirements: An RS-232 port and Windows NT,98 or 95 operating systems.

With each MFT and PTA unit is a 3 ½ " floppy disk that contains the program files for MFTCOMMC and the original factory configuration of the unit.

To install this program you simply execute the 451017-1.41.exe self extracting installation program. You will be prompted with a message telling you what version is being installed. Next you get a WinZip dialog box to choose a destination directory for the installation. The default is C:\Kurz\MFTCOMMC. Once you have selected the destination directory, chose the *Unzip* button. It will say "X files unzipped successfully". Then you *Close* the WinZip utility. Lastly, make a Desktop shortcut or Start menu shortcut to the program MFTCOMMC.exe in the new folder. Now your ready to go.

Menus

The first time you run MFTCOMMC it must be configured for the serial port and baud rate you will use for communicating to the MFT and PTA unit. This is typically the COM1 serial port and 9600 baud. You click on the menu *Communication Port* then select the port and baud rate followed by ok.

Note: None of the Help buttons are implemented in this version of the program. The *File* menu items *New*, *Open*, *Save* and *Save As* are also not implemented.

The main menus are:

File Update Communication Port Help

The *File* menu is used to select:

Upload	(Transfer a file from a MFT or PTA unit to the PC)
Download	(Transfer a configuration file from the PC to the MFT or PTA unit.)
Create Printable File	(convert a configuration file to ASCII text and write it to the PC disk drive.)
View	Look at a configuration file on screen. (Launches Wordpad)
Print	Prints the last file converted to ASCII to your default printer.

The *Update* menu is used at the factory to load flow calibration data to a configuration file and is not discussed here.

The *Communications Port* menu is used to select the baud rate and port described under installation above.

The *Help* menu is not implemented yet but does tell you the version of the program under the *About* button.

Setup for Upload/Download

1. You first connect a straight through RS-232 cable between the PC's COM port and the DB-9 RS-232 port on the user I/O board of the Series MFT or PTA unit.
2. The MFT or PTA must be on and in executive mode. You can not be in Display or Program mode for this to work correctly.
3. Start the MFTCOMMC program and make sure its serial port is correctly configured, see installation above.

Saving an MFT configuration on your PC

1. First setup the hardware and software described above.
2. To save an MFT or PTA configuration you select *File* then *Upload* followed by typing a file name in the name field of the *Save As* file pop-up window.. To see the other files in the directory you will have to change the *Save as type* to *All Files (*.*)*. This type has no impact on the files except what you see in the dialog box. If you want to save the configuration file with the name "Greatflowmeter" then you just type this in with or without an extension. Select the directory where you want to place the file. The configuration file is only about 1.8 kbytes.

3. During the file transfer, a dialog box which says "Wait.... UPLOADING MFT CONFIGURATION". If you do not have the MFT or PTA unit plugged into the RS-232 serial port of the user I/O board or the power is off, this message will stay on the screen. You may have to terminate the program to correct the error and start over. (Control-Alt-Del then select the task)

Viewing or Printing the Configuration File

Once you have a configuration file you can then:

1. Select the option *Create Printable File* under the File menu. After a printable file is created the menu options for *View* and *Print* under File show up. Both the view and print options use WordPad to view or print the file. You close WordPad when done viewing.
2. To print you select *Print* under the *File* menu. When printing, WordPad will be pulled up then closed automatically after sending to the default system printer.

Figure C1 shows a typical configuration file. The length of this printable file depends on the number of data points, temperature data sets and velocity correction factors etc.

Downloading a Configuration from the PC to the MFT or PTA Unit

1. Configure the hardware and software as described above.
2. Transferring a configuration from the PC to the MFT or PTA unit is started by choosing Download under the *File* menu.
3. You select the file to be transferred with the file Open menu.
4. Chose the file type as All to see your files.
5. Chose the proper directory then click Open after you have selected the file. The screen will then pull up a dialog screen which says "Wait... DOWNLOADING THE MFT CONFIGURATION." This takes less than 10 seconds. If it hangs up, check your cable connections, MFT or PTA power and is it in Executive mode? You must terminate the program if it gets stuck. (Control-Alt- Del then select the task)

Figure C1. Sample printable file from MFTCOMMC.

```
CUSTOMER COPY

KURZ INSTRUMENTS, INC.
MFT COMMUNICATION PROGRAM: MFTCOMM VER 1.41
MFT CONFIGURATION FILENAME: C:\Kurz MFTCOMMC\test.cfg
FIRMWARE VERSION: MFT VER 1.12
CONFIGURATION DATE: 5/25/1999

*****FLOW CALIBRATION DATA*****

SENSOR S/N: RD1168A REF. TEMP: 77.000 DEGF
MEDIUM: AIR REF. PRESSURE: 14.690 PSIA
MOL. WT: 28.959999 STD. DENSITY: 0.073931 LB/CF

*****METER #1, FLOWRATE SETUP*****

METER ID: METER 00001 METER UNIT: SCFM

FLOW AREA = 1.000000 SQ.FT
BIAS CORRECTION FACTOR (BCF) = 1.000000
SENSOR BLOCKAGE CORRECTION FACTOR (SBCF):
  SENSOR TYPE: FD16
  SENSOR DEPTH = 0.000000 FT
  SBCF = 1.000000
VARIABLE CORRECTION FACTOR (VCF):
  NUMBER OF CORRECTION PTS. = 1
  D1 = 0.0000 SFPM C.F. #1 = 1.000000
  R1 = 0.0000 SFPM AT 0.0000 SFPM

KICK-OUT STATUS: OFF

  LOW KICK-OUT AT: -100.0000 SFPM
  HIGH KICK-OUT AT: 13000.0000 SFPM
LOW FLOW CUT-OFF STATUS: ON
  LOW FLOW CUT-OFF AT: 0.0000 SCFM
METER SCROLL STATUS: ON
  DISPLAY HOLD TIME: 4 SECONDS

*****METER #2, TEMPERATURE SETUP*****

METER ID: METER 00002 METER UNIT: DEGF
BIAS CORRECTION FACTOR (BCF) = 1.000000
VARIABLE CORRECTION FACTOR (VCF):
  NUMBER OF CORRECTION PTS. = 1
  D1 = 0.0000 DEGF C.F. #1 = 1.000000
  R1 = 0.0000 DEGF AT 0.0000 DEGF
KICK-OUT STATUS: OFF
  LOW KICK-OUT AT: -50.0000 DEGF
  HIGH KICK-OUT AT: 300.0000 DEGF
```

Figure C1. Sample printable file from MFTCOMMC (Continued).

```
METER SCROLL STATUS:  ON
  DISPLAY HOLD TIME:  4 SECONDS

*****METER FILTER SETUP*****

METER #1 TC = 0.500000  SECONDS
METER #2 TC = 0.500000  SECONDS

*****ANALOG OUTPUT SETUP*****

ANALOG OUTPUT #1

ASSIGNED METER NO.: 1

LOW SCALE (4.00 mA) AT  0.0000    SCFM
HIGH SCALE (20.00 mA) AT 6000.0000 SCFM

ANALOG OUTPUT #2

ASSIGNED METER NO.: 2
LOW SCALE (4.00 mA) AT  0.0000    DEGF
HIGH SCALE (20.00 mA) AT 200.0000  DEGF

*****ALARM SETUP*****

ALARM #1    STATUS: OFF    RELAY CONTACT: N.O.
ASSIGNED METER NO.: 1

ALARM FOR: FLOWRATE

ALARM TRIGGER TO: HIGH OR LOW (HOL)
SETPOINTS:
  LOW:  -10.0000  SCFM
  HIGH: 10000.0000 SCFM

ALARM #2    STATUS: OFF    RELAY CONTACT: N.O.
ASSIGNED METER NO.: 2

ALARM FOR: TEMPERATURE
ALARM TRIGGER TO: HIGH OR LOW (HOL)
SETPOINTS:
  LOW:  -10.0000  DEGF
  HIGH: 10000.0000 DEGF
```

Figure C1. Sample printable file from MFTCOMMC (Concluded).

```
*****TOTALIZER PULSE OUTPUT SETUP*****  
*****DATA LOGGING SETUP*****  
  
DATA LOGGING STATUS: OFF  
DATA LOGGING INTERVAL: 5 HOURS 5 MINUTES  
  
*****END OF MFT CONFIGURATION*****
```

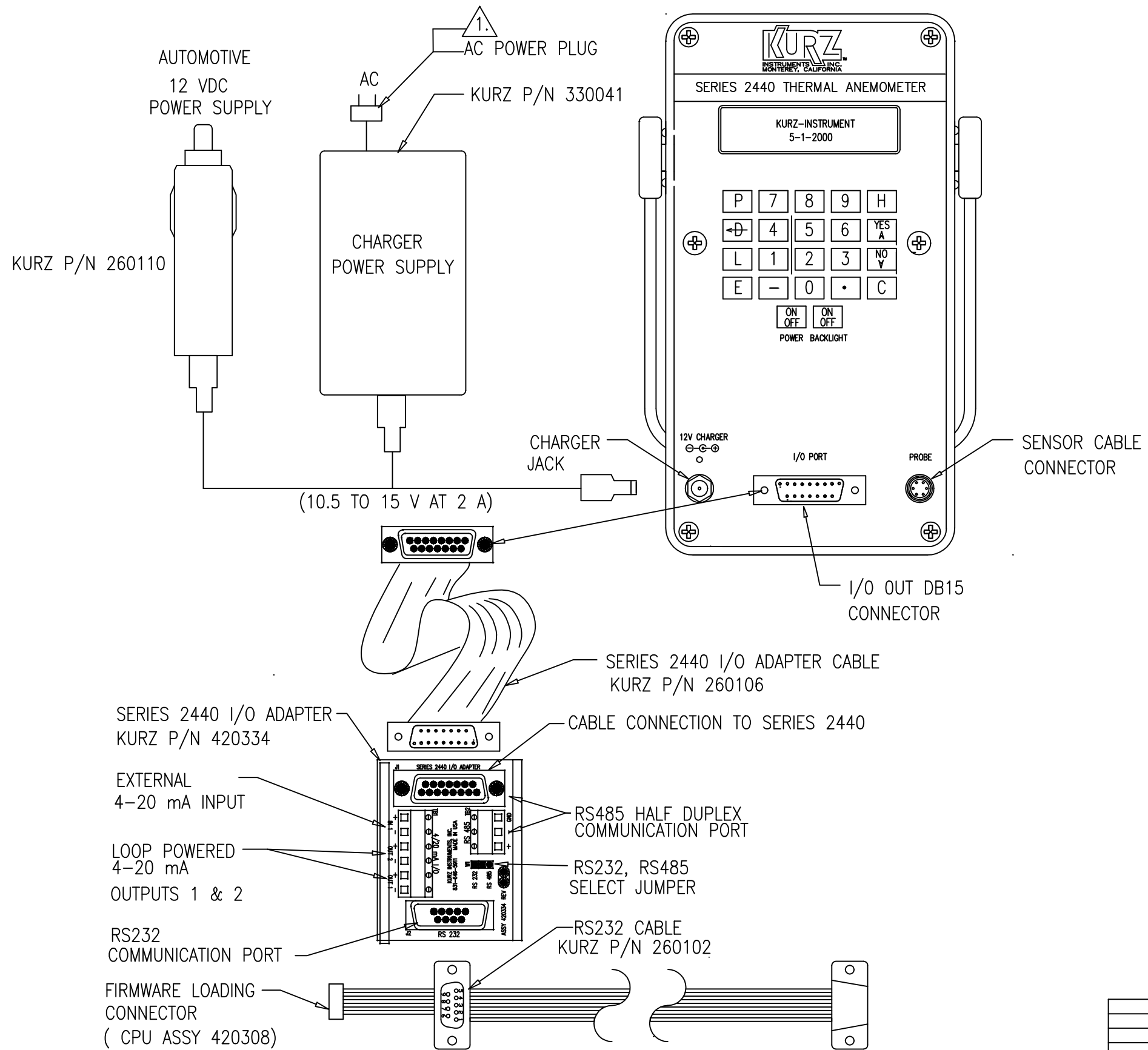
Appendix D

Field Wiring Diagrams

342035 Series 2440 field wiring diagram (4 sheets)

REVISIONS					
REV.	DESCRIPTION	BY	CHKD	APRVD	DATE
A	PER DRF 490317 INITIAL RELEASE	KAB	TW	TW	9.13.2000
B	PER ECO B47735	KAB	TW	TW	10.6.2000
C	PER ECO B47769	KAB			

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1. AC POWER CORDS WITH PLUG

KURZ P/N	DESCRIPTION
260108	NORTH AMERICAN PLUG
260113	EUROPEAN PLUG
260114	GREATBRITAIN PLUG
260115	SOUTH AFRICA PLUG
260117	ARGENTINA PLUG

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		APPROVALS		KURZ INSTRUMENTS, INC.	
TOLERANCES ARE		DRAWN BY	DATE		
FRACTIONS	± 1/16	KAB	9.13.2000	FIELD WIRING DIAGRAM, SERIES 2440	
ANGLES	± 1°-0'	CHECKED BY	DATE		
DECIMALS	± 0.1	T.WILSON	9.13.2000	DWG. NO. 342035	
.XX	± 0.03	APPROVED	DATE		
.XXX	± 0.003	T.WILSON	9.13.2000	SCALE 1" = 1"	
ORIG. RELEASE DATE					
NEXT ASSEMBLY				D	REV. C

4

3

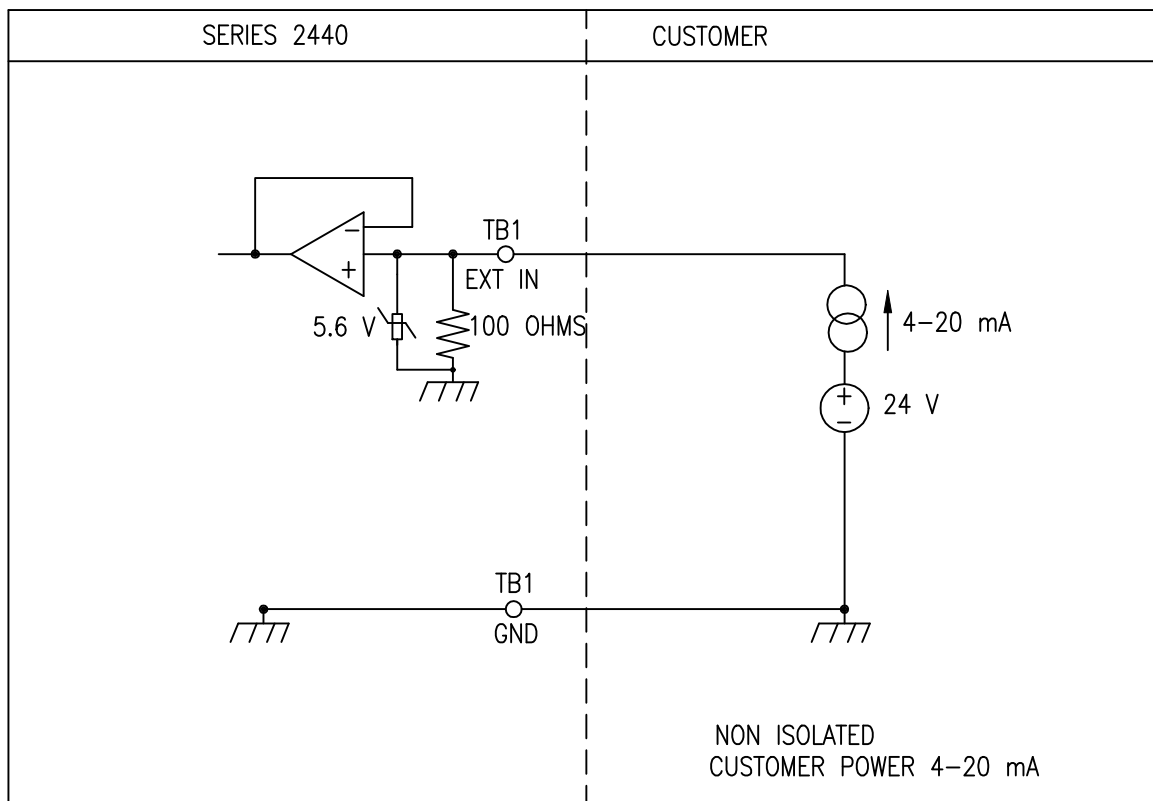
2

1

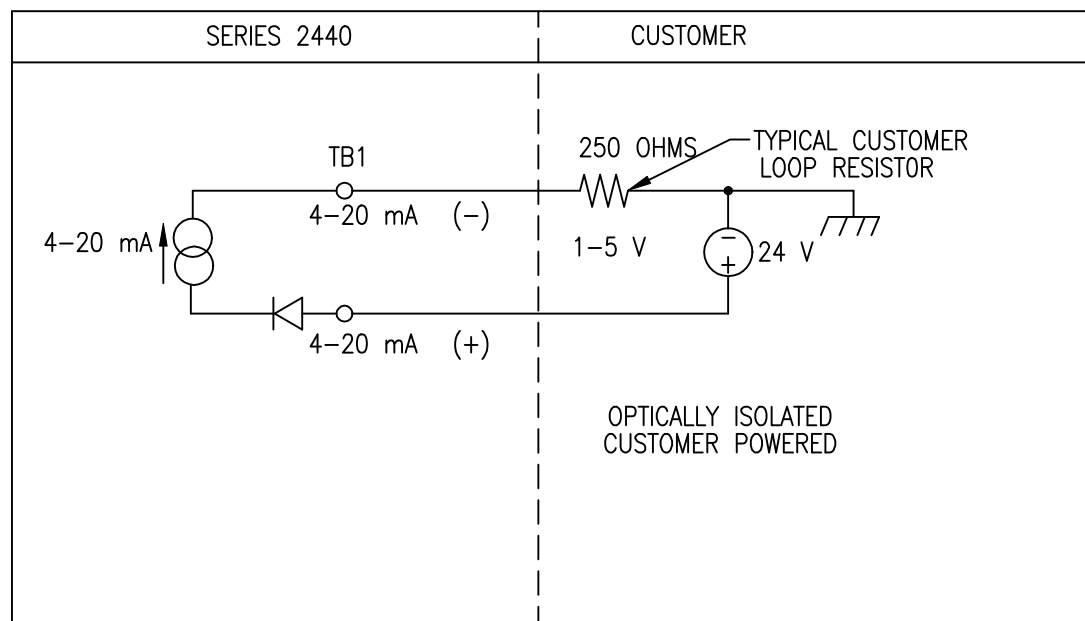
D

D

SAMPLE DIAGRAMS EXTERNAL INPUT



SAMPLE DIAGRAMS 4-20 mA CONNECTIONS



C

C

B

B

A

A

4

3

2

1

KURZ INSTRUMENTS, INC.

FIELD WIRING DIAGRAM
SERIES 2440

DWG. SIZE B	DWG. NO.	342035	REV. C
	SCALE	NONE	SHEET 2 OF 4

4

3

2

1

D

D

C

C

B

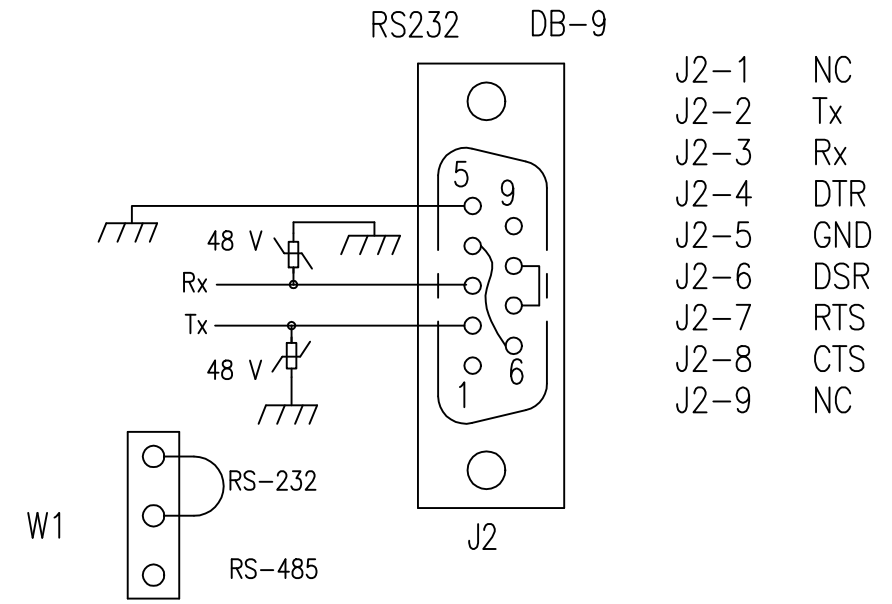
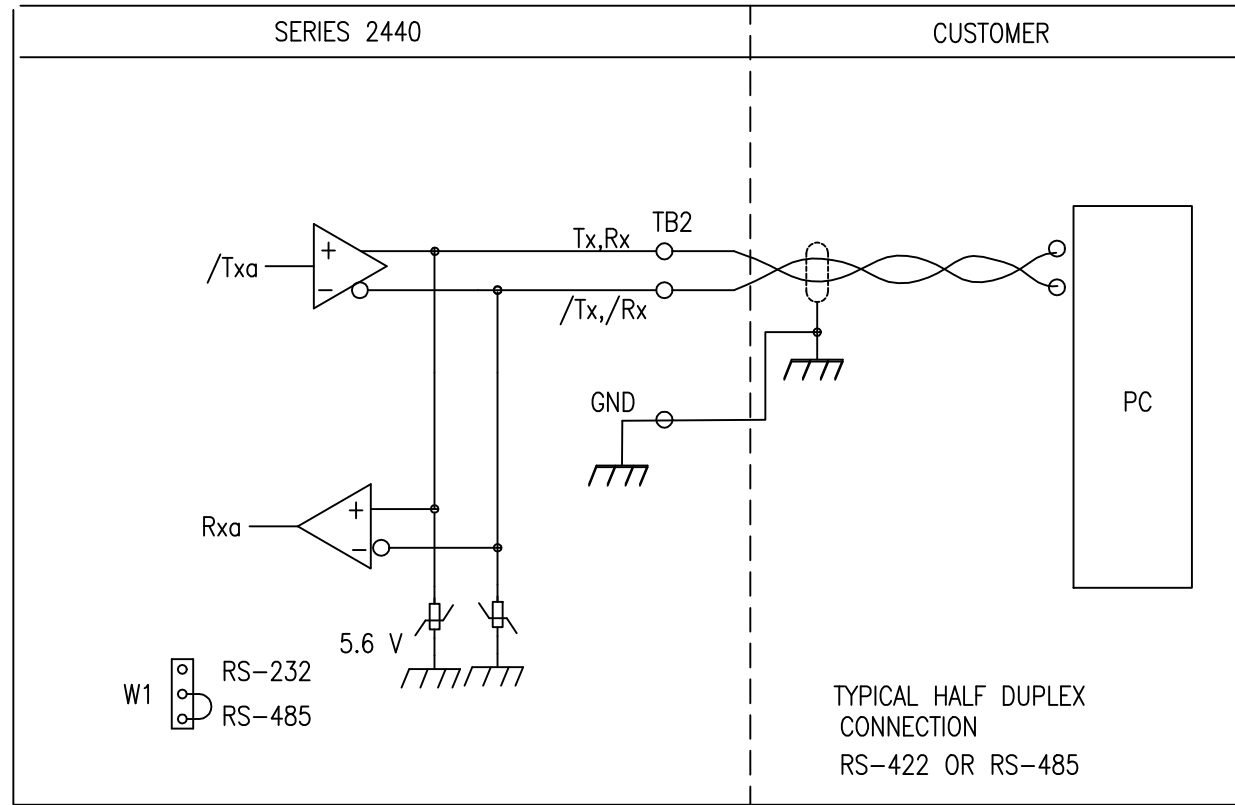
B

A

A

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SERIAL DIGITAL CONNECTIONS



KURZ INSTRUMENTS, INC.

FIELD WIRING DIAGRAM
 SERIES 2440

DWG. SIZE	DWG. NO. 342035	REV. C
B	SCALE NONE	SHEET 3 OF 4

4

3

2

1

4

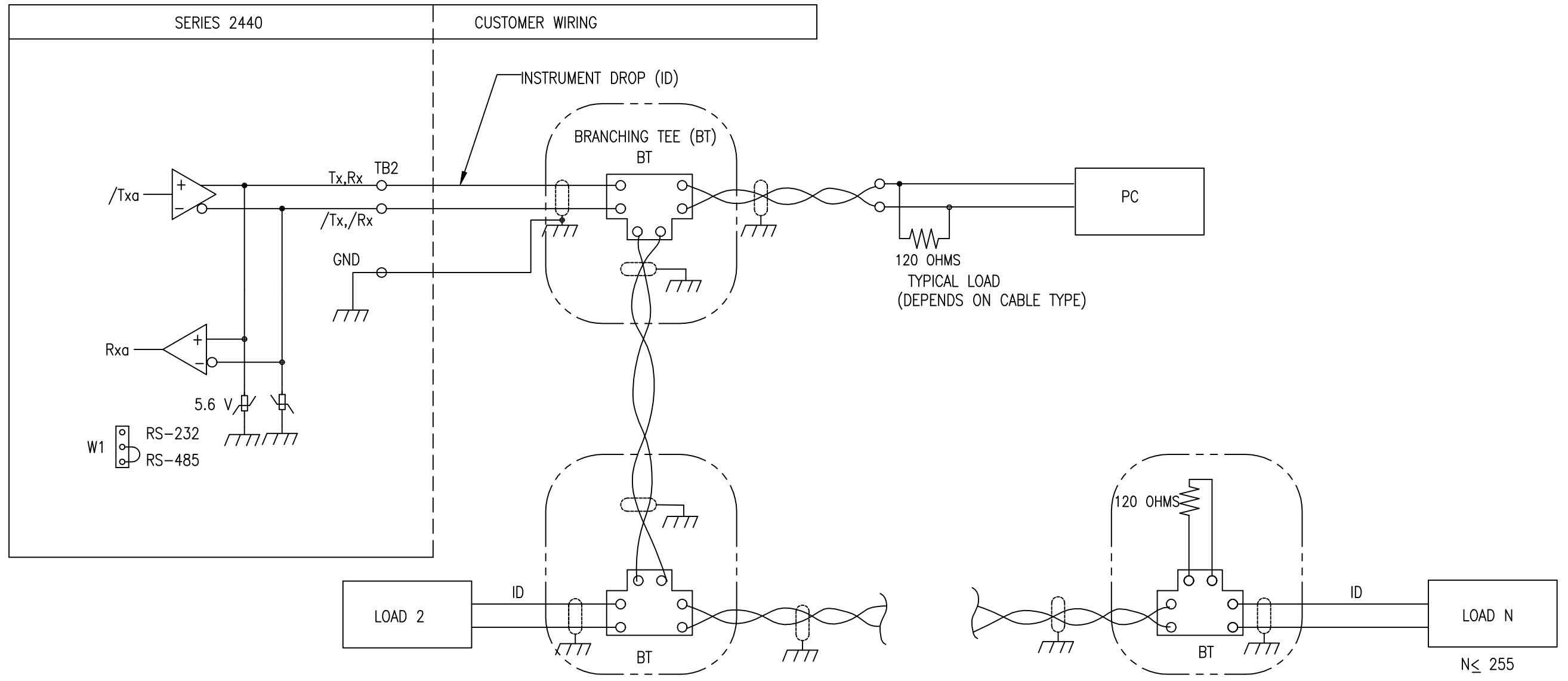
3

2

1

MULTIPOINT SERIAL CONNECTIONS

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TYPICAL LONG DISTANCE HALF DUPLEX CONNECTION RS-485
MULTI DROP OR MULTIPOINT SERIAL CONNECTIONS
MODBUS WIRING CONFIGURATION

KURZ INSTRUMENTS, INC.		
FIELD WIRING DIAGRAM SERIES 2440		
DWG. SIZE	DWG. NO.	REV.
B	342035	C
SCALE	NONE	SHEET 4 OF 4

4

3

2

1

D

C

B

A

D

C

B

A

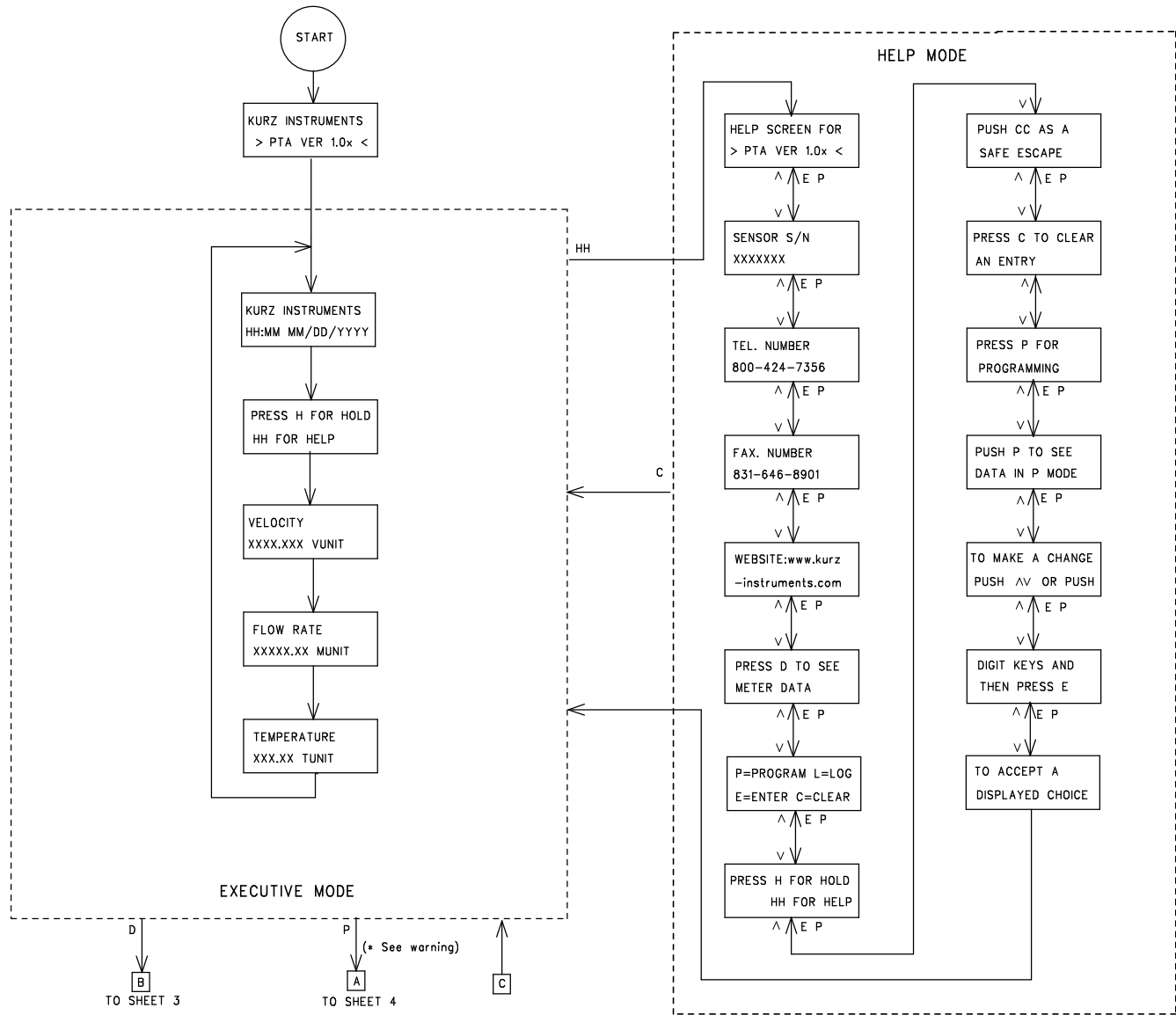
Appendix E

Menu State Diagrams

342034 PTA menu state diagram (12 sheets)

Pages 9, 10 and 11 have been removed which are for the Factory access code.

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* Warning Screen messages when entering to Program Mode.

! WARNING ! NO
OUTPUT UPDATES

WHILE IN
PROGRAM MODE

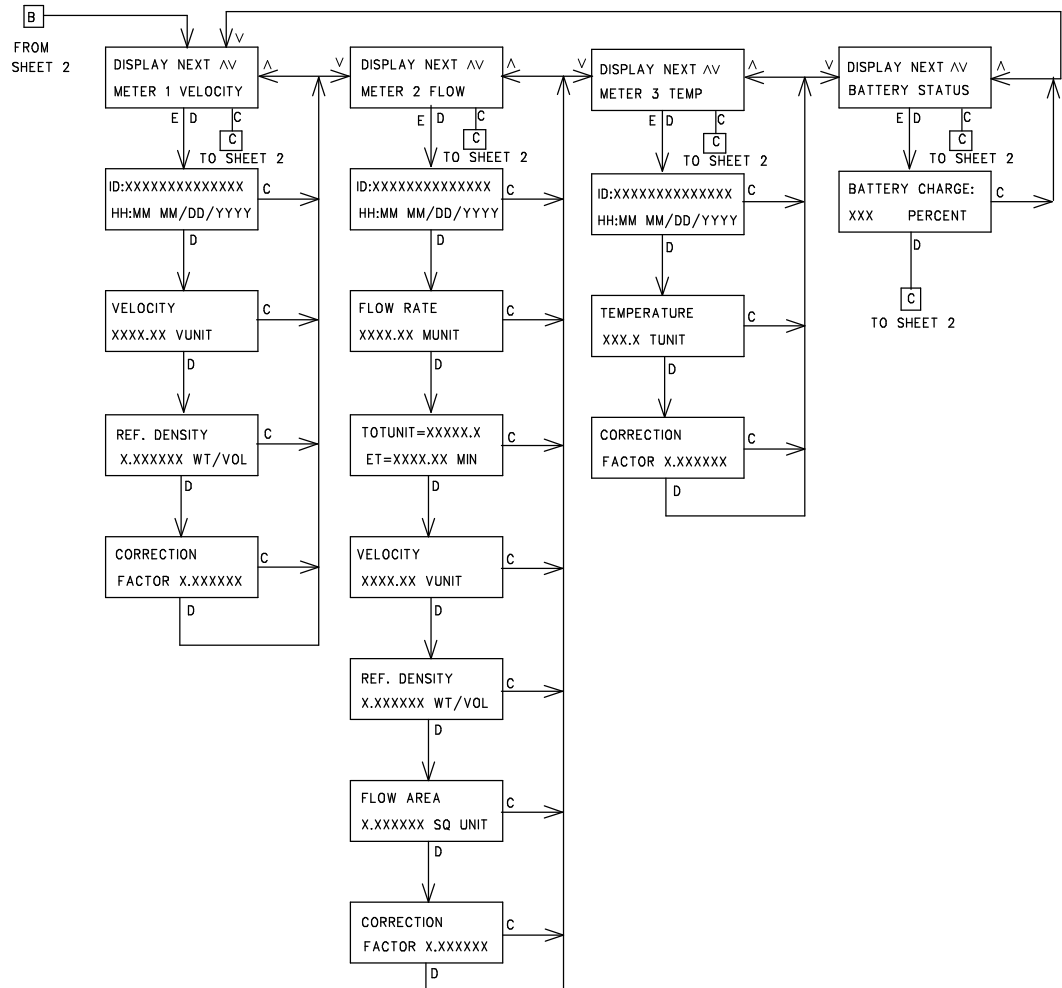
- NOTES:
- MUNIT is a flow meter unit. It can be one of the following: SCFM, SCFH, PPM, PPH, SLPm, SCMH, KGM or KGH.
 - VUNIT is a velocity unit. It can be SFPM or SMPS.
 - TUNIT is a temperature unit. It can be DEGF or DEGC.

NOTE: SHEETS #10&11 ARE FOR FACTORY USE ONLY AND ARE PROPRIETARY.

KURZ INSTRUMENTS, INC.		
TITLE PTA VER 1.0x LCD SCREENS		
DWG. SIZE B	DWG. NO. 342034-1.0	REV. A
SCALE	SHEET 2 OF 12	

TO SHEET 3 [B] TO SHEET 4 [A] (* See warning) [C]

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NOTES:

1. MUNIT is a flow meter unit. It can be one of the following: SCFM, SCFH, PPM, PPH, SLPM, SCMh, KGM or KGH.
2. TOTUNIT is a totalizer unit. It can be one of the following: SCF, LBS, SCM or KGS.
3. VUNIT is a velocity unit. It can be SFPM or SMPS.
4. TUNIT is a temperature unit. It can be DEG F or DEG C.
5. FUNIT is a calibration data flow unit. It can be one of the following: SFPM, SMPS, SCFM or SCMh.
6. SQ UNIT is a unit of area. It can be SQFT or SQM.
7. ET is elapsed time in minutes.
8. CORRECTION FACTOR is the product of the BCF times SBCF or BCF times VCF.
9. The corrected FLOW RATE is the product of AREA times the indicated velocity(FUNIT) times BCF times either SBCF or VCF for INSERTION FLOW METERS, The corrected FLOW RATE is the product of indicated flow rate(FUNIT) times BCF times VCF for IN-LINE FLOW METERS.

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KURZ INSTRUMENTS, INC.		
TITLE PTA VER 1.0x LCD SCREENS		
DWG. SIZE B	DWG. NO. 342034-1.0	REV. A
SCALE	SHEET 3 OF 12	

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6

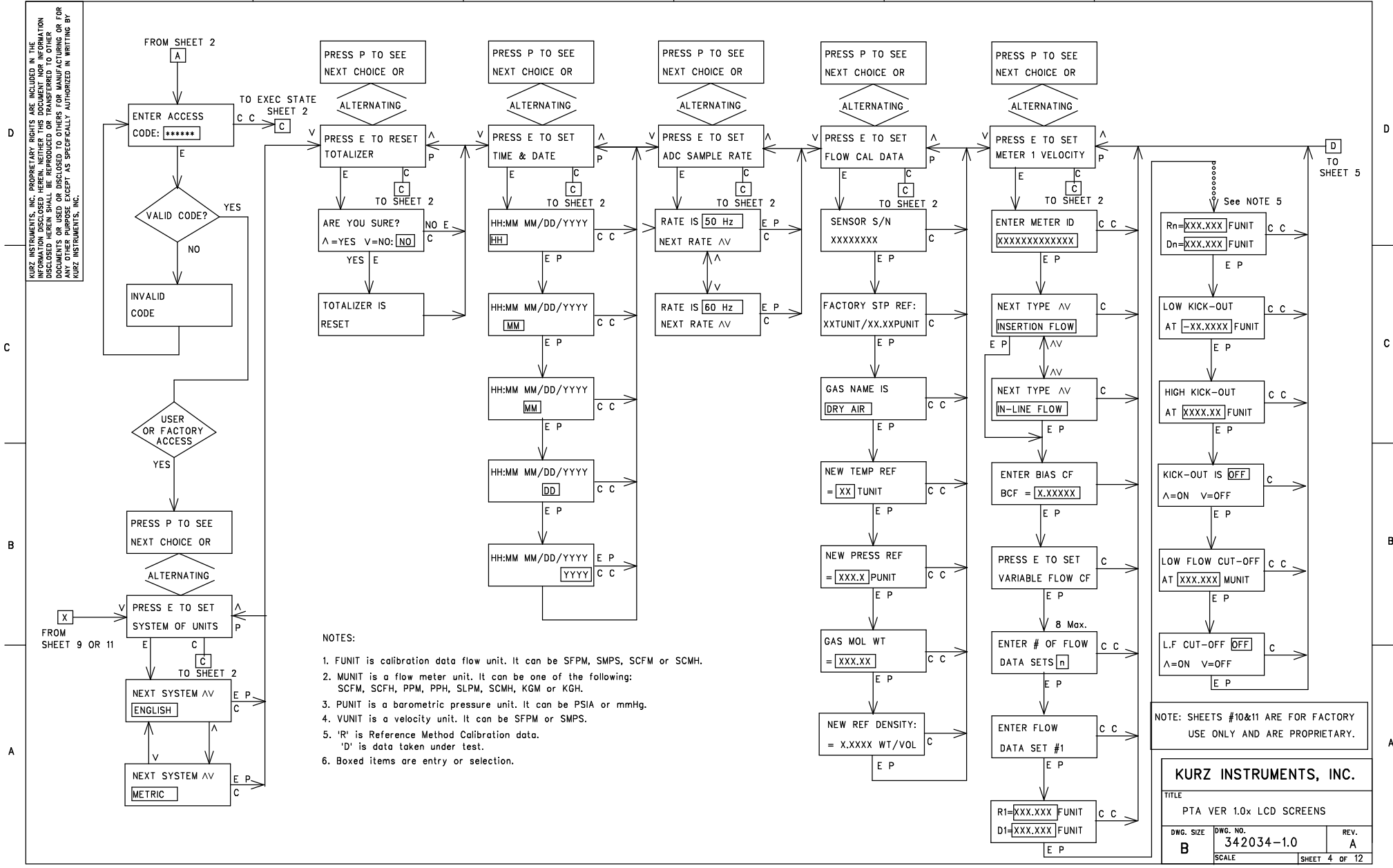
5

4

3

2

1



- NOTES:
1. FUNIT is calibration data flow unit. It can be SFPM, SMPS, SCFM or SCMH.
 2. MUNIT is a flow meter unit. It can be one of the following: SCFM, SCFH, PPM, PPH, SLPM, SCMH, KGM or KGH.
 3. PUNIT is a barometric pressure unit. It can be PSIA or mmHg.
 4. VUNIT is a velocity unit. It can be SFPM or SMPS.
 5. 'R' is Reference Method Calibration data. 'D' is data taken under test.
 6. Boxed items are entry or selection.

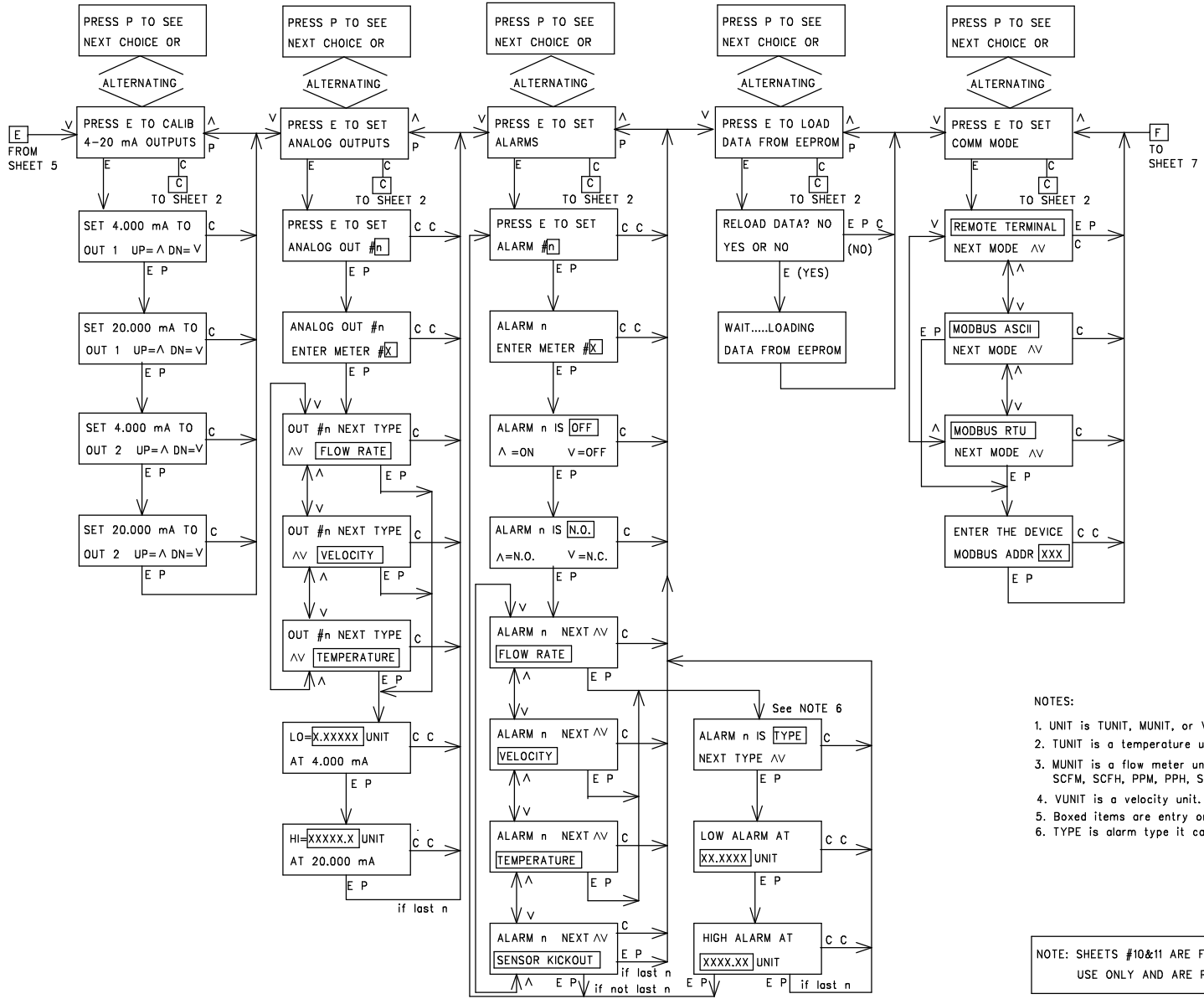
NOTE: SHEETS #10&11 ARE FOR FACTORY USE ONLY AND ARE PROPRIETARY.

KURZ INSTRUMENTS, INC.

TITLE
PTA VER 1.0x LCD SCREENS

DWG. SIZE B	DWG. NO. 342034-1.0	REV. A
SCALE		SHEET 4 OF 12

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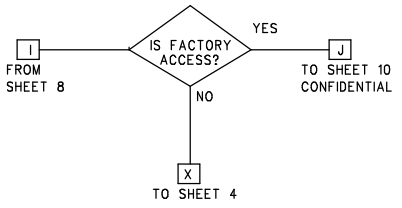


- NOTES:
1. UNIT is TUNIT, MUNIT, or VUNIT.
 2. TUNIT is a temperature unit. It can be DEGf or DEGc.
 3. MUNIT is a flow meter unit. It can be one of the following: SCFM, SCFH, PPM, PPH, SLPM, SCMH, KGM or KGH.
 4. VUNIT is a velocity unit. It can be SFPM or SMPS.
 5. Boxed items are entry or selection.
 6. TYPE is alarm type it can be LOW, HIGH or LOW and HIGH.

NOTE: SHEETS #10&11 ARE FOR FACTORY USE ONLY AND ARE PROPRIETARY.

KURZ INSTRUMENTS, INC.		
TITLE PTA VER 1.0x LCD SCREENS		
DWG. SIZE B	DWG. NO. 342034-1.0	REV. A
SCALE		SHEET 6 OF 12

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MOMENTARY SCREEN MESSAGES

INVALID CODE	This momentary message shows in the event when access code was entered incorrectly. It appears only during access code entry on Program Mode.	WAIT LOGGING IS IN PROGRESS...	This momentary message shows in the event when exporting the data from the extended memory to a PC (host)
TOTALIZER IS RESET	This momentary message shows in the event when the totalizer is reset. It appears only on the RESET TOTALIZER menu.	WAIT...LOADING DATA FROM EEPROM	This momentary message shows in the event when data from the EEPROM is being loaded to the RAM.
HOLD IS ACTIVATED	This momentary message shows in the event when the hold feature is activated by pressing the 'H' key on the keypad or 'h' key on the terminal.	WAIT...SAVING DATA TO EEPROM	This momentary message shows in the event when data from the RAM is being save to the EEPROM.
HOLD IS CLEARED	This momentary message shows in the event when the hold feature is cleared by pressing the 'C' key on the keypad 'c' key on the terminal after the hold feature was activated.		
NEW VALUE ACCEPTED	This momentary message shows in the event when a new entry is entered. It maybe number, text or selection.		
ENTRY NOT IN VALID RANGE	This momentary message shows in the event when a new entry is out of the limits.		
TERMINAL ECHO IS STARTED	This momentary message shows in the event when the terminal echo is enabled by sending an '+' character from the terminal.		
TERMINAL ECHO IS STOPPED	This momentary message shows in the event when the terminal echo is disabled by sending an '+' character from the terminal.		
WARNING !!! BATTERY IS LOW	This momentary message shows in the event when the battery charge is low. This message will show at the Executive, Display and Help state.		
SAMPLE #XXXX IS RECORDED	This momentary message shows in the event when the test log feature is active and new test is stored in the extended memory		

ALARM SCREEN MESSAGES

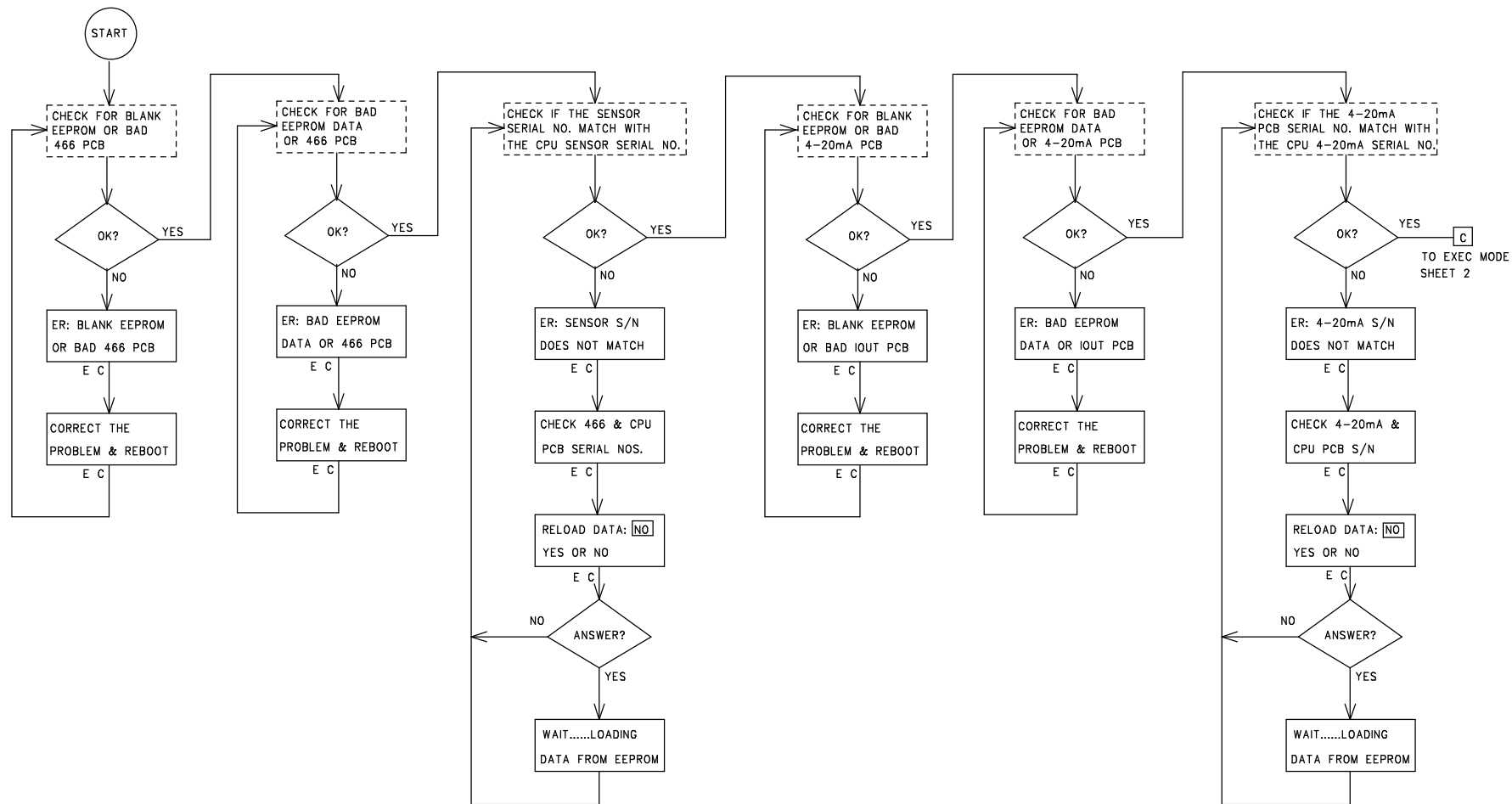
KICKOUT METER n FLOW TOO LOW	HIGH ALARM n FLOW RATE
KICKOUT METER n FLOW TOO HIGH	LOW ALARM n VELOCITY
KICKOUT METER 3 TEMP TOO LOW	HIGH ALARM n VELOCITY
KICKOUT METER 3 TEMP TOO HIGH	LOW ALARM n TEMPERATURE
LOW ALARM n FLOW RATE	HIGH ALARM n TEMPERATURE

n = 1 or 2

NOTE: SHEETS #10&11 ARE FOR FACTORY USE ONLY AND ARE PROPRIETARY.

KURZ INSTRUMENTS, INC.		
TITLE PTA VER 1.0x LCD SCREENS		
DWG. SIZE B	DWG. NO. 342034-1.0	REV. A
SCALE	SHEET 9 OF 12	

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- NOTES:
1. Boxed items are entry or selection.
 2. To bypass the power up diagnostic routine, press the 'C' or 'E' on the keypad just after the display goes blank during reset or power up.

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KURZ INSTRUMENTS, INC.		
TITLE PTA VER 1.0x LCD SCREENS		
DWG. SIZE B	DWG. NO. 342034-1.0	REV. A
SCALE	SHEET 12 OF 12	

Appendix F

Signal Flow Diagram

342036 Series 2440 signal flow diagram

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6

5

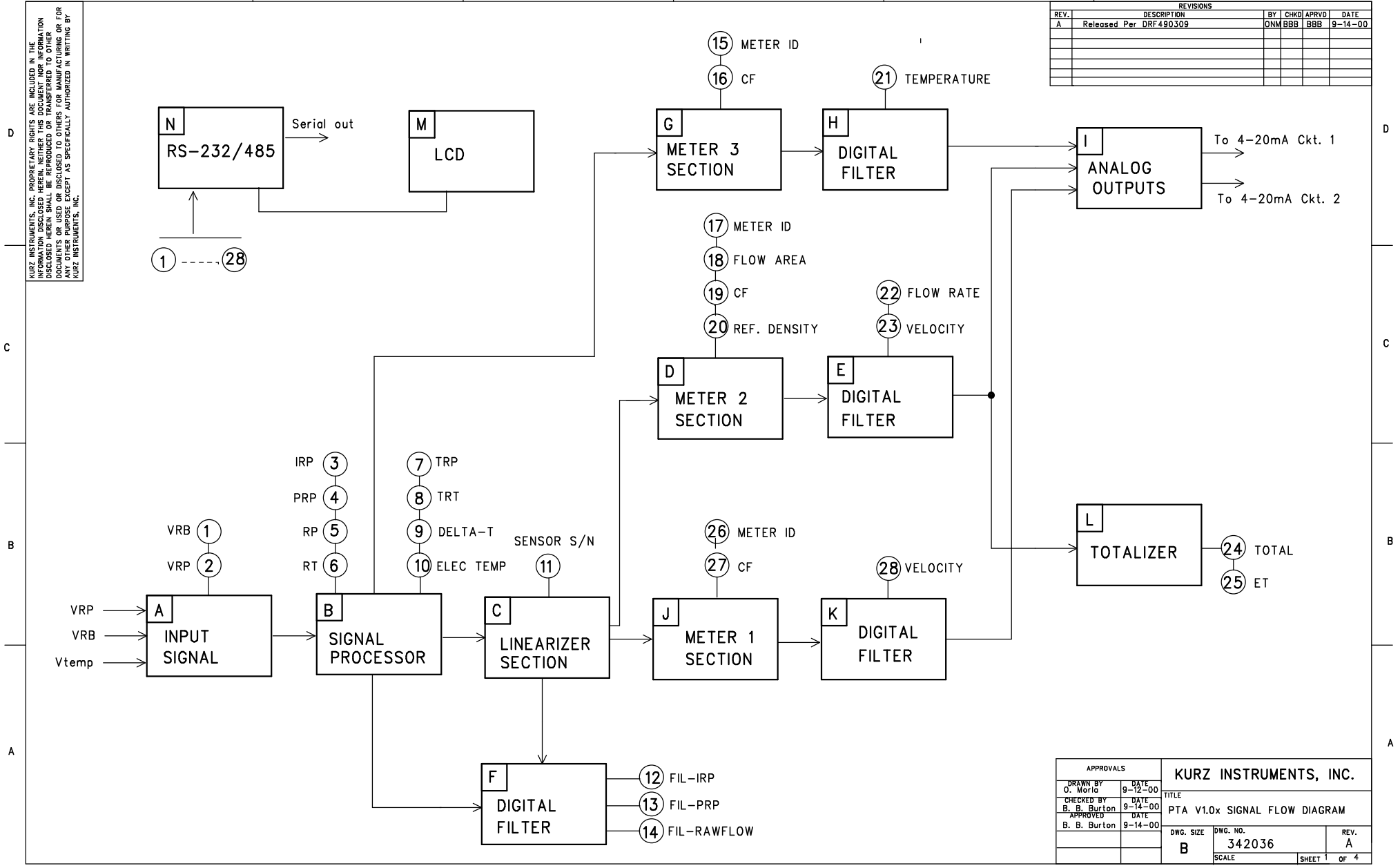
4

3

2

1

REVISIONS					
REV.	DESCRIPTION	BY	CHKD	APRVD	DATE
A	Released Per DRF 490309	QNM	BBB	BBB	9-14-00



APPROVALS		KURZ INSTRUMENTS, INC.	
DRAWN BY	O. Morio	DATE	9-12-00
CHECKED BY	B. B. Burton	DATE	9-14-00
APPROVED	B. B. Burton	DATE	9-14-00
DWG. SIZE		DWG. NO.	REV.
B		342036	A
SCALE		SHEET 1 OF 4	

FUNCTION BLOCK DESCRIPTION:

A INPUT SIGNAL

This section is use to read the analog input voltages. Convert the votage to digital values by the Analog to Digital Converter (ADC) and apply the input calibration factors.

B SIGNAL PROCESSOR

This section is use to calculate the value of the Rp current (IRP), Rp power(PRP), Rp resistance(RP), Rtc resistance(RT), Rtc temperature(TRT), Rp temperature(TRP), delta temperature(TRP-TRT) and the electronics temperature.

C LINEARIZER SECTION

This section is use to calculate the flowrate or velocity using the La Grangian interpolation from the Flow calibration table. If the flow calibration data has multiple data sets, it will perform a Velocity Temperature Mapping(VTM) calculation.

D METER 2 SECTION

This is use to calculate the value of the flowrate equivalent to the selected Engineering unit. The output of this section is a corrected flowrate and velocity applying the following correction factors; Bias Correction Factor(BCF), Variable Correction Factor (VCF) and Sensor Blockage Correction Factor (SBCF). The calculations are:

INSERTION FLOW METER

Vol. Flow = (SBCF)(BCF)(VCF)(Flow Area)(Ind. Velocity)
Mass Flow = (Vol. Flow)(Gas Density).
Velocity = Vol. Flow/Flow Area.

INLINE FLOW METER

Vol. Flow = (BCF)(VCF)(Ind. Flowrate).
Mass Flow = (Vol. Flow)(Gas Density).
Velocity = Vol. Flow/Flow Area.

E DIGITAL FILTER

This is a first order low pass filter (RC time constant) to the flow rate and velocity. The filtering depends on the value of the METER 2 Time Constant.

F DIGITAL FILTER

This is a first order low pass filter (RC Time Constant) to the raw flow rate or velocity, Current through sensor Rp (IRP) and Power dessipated across sensor Rp (PRP). The filtering depends on the value of the METER 1 Time Constant.

G METER 3 SECTION

This is use to calculate the value of the process temperature. The temperature is calculated using the expression below:
Temperature = (BCF)(VCF)(Ind. Temperature).

H DIGITAL FILTER

This is a first order low pass filter (RC time constant) to the process temperature. The filtering depends on the value of the METER 3 Time Constant.

I ANALOG OUTPUTS

This is use to calculate the voltage that will be sent to the Digital to Analog Converter (DAC). This voltage is calculated to correspond to the flow rate, velocity or temperature read by the meters. The calibration coefficient of the 4-20 mA output will be accounted for to compensate for the 4-20 mA circuit. There are two outputs which can be assigned to METER 1 or METER 2 or METER 3. The output can be setup with the linear scale of flow rate, velocity or temperature versus the output current.

J METER 1 SECTION

This is use to calculate the value of the velocity. For Inline flow meter, the velocity is derived by dividing the flow rate over the cross-sectional are of the pipe defined in Meter 2.

K DIGITAL FILTER

This is a first order low pass filter (RC time constant) to the process temperature. The filtering depends on the value of the METER 1 Time Constant.

L TOTALIZER

This is use to totalize the flowrate and monitor the elapsed time since the totalizer was last reset.

M LCD

This is a 16x2 characters Liquid Crystal Display (LCD) and the operator interface display to the instruments.

N RS-232/485

Another way to interface to the instrument is using the RS-232 or the RS-485 serial interface to a PC.

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KURZ INSTRUMENTS, INC.

TITLE
PTA V1.0x SIGNAL FLOW DIAGRAM

DWG. SIZE B	DWG. NO. 342036	REV. A
SCALE		SHEET 2 OF 4

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DISPLAY ITEMS DESCRIPTION

① VRB

This is a voltage reading of the input signal VRB, voltage across the Rb resistor on the bridge circuit. The voltage value can be displayed under the menu "SEE DIAGNOSTIC DATA" with the label VRB.

② VRP

This is a voltage reading of the input signal VRP, voltage across the Rp sensor on the bridge circuit. The voltage value can be displayed under the menu "SEE DIAGNOSTIC DATA" with the label VRP.

③ IRP

This is a current reading flowing through the Rp sensor. The value is calculated using Ohm's Law, $IRP = VRP/Rb$. The value of IRP can be displayed under the menu "SEE DIAGNOSTIC DATA" with the label IRP.

④ PRP

This is a power reading dissipated through the Rp sensor. The value is calculated by the equation, $PRP = (IRP)(VRP)$. The value of PRP can be displayed under the menu "SEE DIAGNOSTIC DATA" with the label PRP.

⑤ RP

This is the ambient resistance reading of the RP sensor. The value is calculated using Ohm's Law, $RP = VRP/IRP$. The value of RP can be displayed under the menu "SEE DIAGNOSTIC DATA" with the label RP.

⑥ RT

This is the ambient resistance reading of the RT sensor. The value is calculated based on the properties of a balanced bridge. The value can be displayed under the menu "SEE DIAGNOSTIC DATA" with the label RT.

⑦ TRP

This is the overheat temperature reading of the Rp sensor. The value is calculated from the Platinum Resistance/Temperature equation. The value can be displayed under the menu "SEE DIAGNOSTIC DATA" with the label TRP.

⑧ TRT

This is the process temperature reading of the Rtc sensor. The value is calculated from the Platinum Resistance/Temperature equation. The value can be displayed under the menu "SEE DIAGNOSTIC DATA" with the label TRT.

⑨ DELTA-T

This is the difference temperature of the TRP and TRT. The value is calculated as, $\Delta T = TRP - TRT$. The value can be displayed under the menu "SEE DIAGNOSTIC DATA" with the label DELTA TEMP.

⑩ ELEC TEMP

This is the temperature reading inside the MFT enclosure. The value is measured by semiconductor device. The value can be displayed under the menu "SEE DIAGNOSTIC DATA" with the label ELECTRONICS TEMP.

⑪ SENSOR S/N

This is the Serial Number of the sensor.

⑫ FIL-IRP

This is the filtered Rp current. The filtering depends on the value of meter 1 filter time constant. This Rp current is use for flow calibration data acquisition. It can be displayed at display mode under "SEE DIAGNOSTIC DATA" with the label IRP=.

⑬ FIL-PRP

This is the filtered Rp power. The filtering depends on the value of meter 1 filter time constant. This Rp power is use for flow calibration data acquisition. It can be displayed in display mode under "SEE DIAGNOSTIC DATA" with the label PRP=.

⑭ FIL-RAWFLOW

This is the filtered raw flow rate. This value is the result of interpolation from the calibration data in the linearizer table. If the calibration data has multiple data sets, the value is derived from VTM interpolation. This value is referred to "Indicated Flow". It can be displayed in display mode under "SEE DIAGNOSTIC DATA".

⑮ METER ID

This is the Identification of Meter 3. It can be displayed in display mode under "METER 3 TEMP" with the label ID.

⑯ CF

This is the total correction factor for the temperature meter. The correction factor is calculated as: $CF = (BCF)(VCF)$. It can be displayed in display mode under "METER 3 TEMP" with the label CF.

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TITLE
PTA V1.0x SIGNAL FLOW DIAGRAM

DWG. SIZE	DWG. NO.	REV.
B	342036	A
SCALE	SHEET 3 OF 4	

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17 METER ID

This is the Identification of Meter 2. It can be displayed in display mode under "METER 2 FLOW" with the label ID.

18 FLOW AREA

This is the cross-sectional area of the duct or pipe in SQFT or SQM. It can be displayed in display mode under "METER 2 FLOW" with the label FLOW AREA.

19 CF

This is the total correction factor. $CF = (SBCF)(BCF)(VCF)$ for insertion meters and $CF = (BCF)(VCF)$ for inline flow meters. The CF can be displayed in display mode under "METER 2 FLOW" with the label CORRECTION FACTOR.

20 REF. DENSITY

This is the Reference Gas Density. The density is calculated from the Standard reference temperature, pressure and the Molecular Weight of the Gas. The Ref Density can be displayed in display mode under "METER 2 FLOW" with the label REF. DENSITY.

21 TEMPERATURE

This is the filtered process temperature. The filtering depends on the value of the METER 3 time constant. The value can be displayed in display mode under "METER 3 TEMP" with the label TEMPERATURE. It can be displayed also in the Executive state if the METER 2 scroll is ON.

22 FLOW RATE

This is the filtered flow rate. The filtering depends on the value of the METER 2 time constant. The flow rate can be displayed in display mode under "METER 2 FLOW" with the label FLOW RATE. It can be displayed also in the Executive state if the METER 2 scroll is ON.

23 VELOCITY

This is the filtered Velocity. The filtering depends on the value of the METER 2 time constant. The Velocity can be displayed in display mode under "METER 2 FLOW" with the label VELOCITY.

24 TOTAL

This is the flow total since the totalizer was last reset. It can be displayed in display mode under "METER 2 FLOW" with the label "(Volume/Mass Unit)". The Volume unit can be SCF, LBS, SCM, KGS or SL. It can be displayed also in the Executive state if the METER 1 scroll is ON.

25 ET

This is the Elapsed Time since the totalizer was last reset. It can be displayed in display mode under "METER 2 FLOW" with the label "ET". It can be displayed also in the Executive state if the METER 2 scroll is ON.

26 METER ID

This is the Identification of Meter 1. It can be displayed in display mode under "METER 1 VELOCITY" with the label ID.

27 CF

This is the total correction factor. $CF = (BCF)(VCF)$ for insertion and inline meters. The CF can be displayed in display mode under "METER 1 VELOCITY" with the label CORRECTION FACTOR.

28 VELOCITY

This is the filtered velocity. The filtering depends on the value of the METER 1 time constant. The flow rate can be displayed in display mode under "METER 1 VELOCITY" with the label VELOCITY. It can be displayed also in the Executive state if the METER 1 scroll is ON.

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TITLE
PTA V1.0x SIGNAL FLOW DIAGRAM

DWG. SIZE	DWG. NO.	REV.
B	342036	A
SCALE	SHEET 4 OF 4	

Appendix G

Digital Communications

INTRODUCTION

The Kurz Instruments Series MFT and PTA units have three modes of data communications using the RS-232 or RS-485 interface. It is available starting on the MFT firmware version 1.2x and PTA 1.0x. The three communication modes are the following:

1. Remote Terminal,
2. Data Logging, and
3. Modbus Protocol.

The **Modbus Protocol** has two transmission modes; they are ASCII and RTU. All the three modes of data communication uses a common serial port of the microprocessor so one mode can be used only at time. The RS-232 and RS-485 interface uses also the same port of the microprocessor so they can not be used simultaneously.

The **Remote Terminal** mode is used with the RS-232 or RS-485 Full Duplex to communicate with a computer terminal (PC or Laptop). This mode is usually use to setup the configuration and Upload or Download the configuration file of the Series MFT/PTA (RS-232 interface only for Upload or Download).

The **Data Logging** mode is used with the RS-232 or RS-485 Full Duplex to log data from the MFT/PTA to serial device like serial printer or computer terminal. The output of the log is character string and can be setup with a periodic time interval or forced it to log using the command 'I' or 'L' at the local display. It is advisable to turn off the terminal echo to prevent undesirable data to be transmitted.

The Modbus mode is used with the RS-232 (point to point) or RS-485 (point to point or multi-drop). The RS-485 can be configured as a Full Duplex or Half Duplex. Modbus is a network communication protocol that was originally developed by Modicon (*Company Name*) for their controllers. The controllers can communicate using master-slave technique, in which only one device (*the master*) can initiate transactions (*called the queries*). The other devices (*the slaves*) respond by supplying the requested data to the master, or by taking the action requested in the query. The master can address individual slaves, and the slave will respond by returning a message (*called response*) to the query that is individually addressed to it. The Modbus protocol establishes the format

for the master's query by placing into the device address, a function code defining the requested action, any data to be sent and an error checking field for each data packet. The slave's response message is also constructed using Modbus protocol. It contains field confirming the action taken any data to be returned and an error checking field. If an error occurred in receipt of the message or the slave is unable to perform the requested action, the slave will construct an error message and send it as its response. The ASCII or RTU transmission mode are available in the Series MFT/PTA.

COMMUNICATION SETUP

Setup for Remote Terminal Mode

Remote Terminal communication mode is the default (unless customer specified) It allows the user to communicate with the MFT/PTA by using a computer or RS-232 communication terminal. The communication can be done by using the RS-232 or RS-485 Interface at Full Duplex transmission. When the communication is established the MFT/PTA will echo all the information that is being displayed to the local LCD display to the computer terminal. It will also allows the user to key in the keyboard command from the computer keyboard like the 'p' (P key from the local keypad) for programming, 'd' (D key from the local keypad) for display.

Follow the following steps to setup the Series MFT/PTA for this mode:

1. Refer to the Appendix D of the Series 454FT or Series 504FT User's Guide for Field Wiring Diagram.
2. If your unit has the Modbus feature, press the **P** key on the local keypad, the MFT/PTA will respond by displaying the warning message, wait approximately 6 seconds and will prompt you to enter the access code. If the Modbus feature is not available, Remote Terminal is setup as default.
3. Enter the access code "123456"(default) then press the **E** key.
4. Press the **P** or the \wedge v key repeatedly until the "PRESS E TO SET COMM MODE" is displayed.
5. Press the **E** key and select the "REMOTE TERMINAL" from the selection using the \wedge v arrow. Press the **E** key to accept.
6. At this point the MFT/PTA is setup for Remote Terminal mode.
7. Run the PC or Laptop with communication terminal emulation software. If you are using the Windows 95,98 or NT use the Hyperterminal program that came with it. To run the Hyperterminal Program, do the following:
 - Click the Start button, select Programs, then Accessories, and then Hyperterminal then click Hyper Terminal.

- The program will run and pop up a window called “Connection Description”.
- Enter a name (filename) and select an icon and click the OK button.
- Another window will pop up called “Connect To”. Since the RS-232 port will be used, select the box labeled “Connect using” and select COM1 or COM2 or COM3 depending what communication port you are using then click the OK button.
- Another window will pop up called “Port Setting”. This is where you configure the RS-232 communication parameters.
- At the box labeled “Bits per second” select the proper baud rate configured in the Series MFT/PTA, the default Series MFT/PTA baud rate is 9600 baud. If the MFT/PTA unit baud rate set at 9600 baud, select the 9600 baud in this box. At the “Data bits” box select 8, the “Parity” box select None, “Stop bits” box select 1 and the “Flow control” box to None. Click the OK button when everything was selected. At this point you should see a data on the program window received from the Series MFT/PTA.
- If no data is being received, press the ‘+’ key on the keyboard to command the Series MFT/PTA to start echoing data. Save the connections for future use by clicking the File menu then Save.

Setup for Data Logging Mode

The Data logging mode is an extension feature of the Remote Terminal mode. When this feature is available, the Series MFT/PTA allows the user to setup a periodic log interval for the Series MFT/PTA to log data to a serial device like computer terminal or serial printer. In addition, the Series MFT/PTA can be force to log the MFT/PTA data by using the ‘l’ (‘L’ key from the local keypad) command. The format of the data is a text string consists of three lines terminated with the RETURN character (ASCII 13). The first line is the time and date when the data was logged. The second line is Flow Meter (Meter #1) data consist of the following:

- The Meter Number.
- The Meter Identification (Meter ID).
- The flow rate and the engineering unit.
- The Total flow and the unit.

The third line is the Temperature Meter (Meter #2) data consist of the following:

- The Meter Number.
- The Meter Identification (Meter ID).
- The Temperature and the engineering unit.

Example data from the Series MFT/PTA log function or the ‘l’ command:

```
Host issues |
MFT/PTA reply    13:58:23 2/09/99
                 #1 FT456 0.23459 SCFM 1.238999e3 SCF
                 #2 TT456 125.71 DEGF
```

Follow the following steps to setup the Series MFT/PTA for this mode:

1. Follow the setup for the Remote Terminal Mode (See section “Setup for Remote Terminal Mode). The Serial communication must be established before the data logging will work.
2. Send the ‘l’ character from the computer terminal or the **L** from the local keypad. If the communication is working properly, the Series MFT/PTA should reply a text string like the example above. In order to have a clean uncluttered reply on the computer terminal display or serial printer, turn off the terminal echo. Sending the ‘+’ command will toggle the status of the terminal echo.
3. The periodic log interval can be setup in the program mode. Press **P** on the local keypad or send ‘p’ if you are using the computer terminal. The Series MFT/PTA will respond by displaying the warning message. After approximately 6 seconds, the Series MFT/PTA will ask for the access code, enter the access code “123456”(factory default). Press the \wedge v arrow repeatedly until you reach the menu “SET DATA LOGGING”. Press **E** on the local keypad or the return from the computer terminal.
4. Turn ON the data log and enter the data log time interval, enter the minutes then the seconds.
5. Press **C** to exit to the executive mode.

Setup for Modbus Mode

The Series MFT/PTA can be configured for Modbus protocol communications. The Modbus mode of transmission can be selected either Modbus ASCII or Modbus RTU. The Series MFT/PTA must be used only as slave devices and they will work only if they are used with a master device. RS-232 or RS-485 Interface can be used to communicate with the Series MFT/PTA. The RS-232 can be use only as a Full Duplex for point to point communication (Master and Slave). The RS-485 can be use either Full Duplex or Half Duplex and can be point to point or multi-drop (1 Master and 1 or more Slaves) operation. Each slave devices must have its unique device address within the network. The individual slave device address can be assigned in the range of 1-247.

WARNING

Do not connect the Series MFT/PTA to the Modbus Network until it is properly configured.

The MFT/PTA Series may be setup for Modbus communications if the option is available. Follow the following instructions to setup for Modbus operation:

1. Press the **P** key on the local keypad, the MFT/PTA will respond by displaying the warning message, wait approximately 6 seconds and will prompt you to enter the access code.
2. Enter the access code "123456"(default) then press the **E** key on the local keypad.
3. Press the **P** or the \wedge V key repeatedly until the "PRESS E TO SET COMM MODE" is displayed.
4. Press the **E** key and select the "MODBUS ASCII" or "MODBUS RTU" from the selection. Press the **E** key to accept. The communication parameters for the Modbus ASCII are the following:

7 Databits
No Parity
2 Stop bits

The baud rate may be selected under the menu "SET RS-232 BAUD RATE". The factory default is 9600 baud.

The communication parameters for the Modbus RTU are the following:

8 Databits
No Parity
1 Stop bit

The baud rate may be selected under the menu "SET RS-232 BAUD RATE". The factory default is 9600 baud.

1. The next display is used to assign the slave address of the Series MFT/PTA. Enter the slave address (valid range 1-247) and press the **E** key. If the Series MFT/PTA will be used in a multi-drop network, make sure that you assigned an address unique to all of the devices connected to the network. The default address set in the factory is 1.
2. Press the **C** key to return to the executive mode.
3. Refer to Appendix D of the Series 2440 field wiring diagrams.

SERIES MFT/PTA MODBUS COMMAND AND REGISTERS

The Modbus function codes are expressed in byte length (8 bits), example function code:

- 01 = Read Coil Status
- 02 = Read Input Status
- 03 = Read Holding Registers

The Series MFT/PTA only support the function code 03, Read the Holding register of the Series MFT/PTA. A register is defined as a 16-bit storage of data. This means that an integer number will occupy one register, floating point number will occupy two registers and two ASCII characters in one register.

These registers are mapped to the internal variables of the Series MFT/PTA and are available to access by specifying the equivalent Modbus register. The table below defined the Modbus register of the Series MFT/PA and description of the internal variables:

Modbus Register # Function Code 03	Series MFT/PTA Holding Register Description	Data Type C-Compilers
00-01	Flow Rate	Float
02-03	Velocity	Float
04-05	Temperature	Float
06-07	Total Flow	Float
08-09	Elapsed Time	Float
10-11	Flow rate Correction Factor	Float
12-13	Temperature Correction Factor	Float
14-15	Flow Area	Float
16-17	Density	Float
18-22	Serial Number	ASCII (char)
23-26	Velocity Unit	ASCII (char)
27-30	Flow rate Unit	ASCII (char)
31-34	Total Flow Unit	ASCII (char)
35-38	Temperature Unit	ASCII (char)
39-45	Flow Meter Identification (Meter ID)	ASCII (char)
46-52	Temperature Identification (Meter ID)	ASCII (char)

In order to access the desired data of the Series MFT/PTA, The master will query the holding register that is mapped to the internal variable of the Series MFT/PTA. For example, you want to read the velocity reading, then the master must assemble a command with the slave device address, a function code 03, starting register to read 02 and number of register to read is 2 registers and calculate the error checking value.

Appendix H

Velocity Traverse Field

Calibrations

LD-3802 In-Situ Field Calibration (11 sheets)

REVISION HISTORY

REV.	AUTHORIZED BY DRF# OR ECO#	ORIG. BY	CHKD. BY	APRVD. BY	DATE
1	DRF 490319	BBB	DD	BBB	12-15-2000

In-Situ Field Calibration
PROCEDURE# LD-3802 Rev. A

APPROVALS		ACKNOWLEDGMENTS		
ORIGINATED BY:	DATE:	DEPT.	SIGNED	DATE
Bruce Burton	12-7-00			
CHECKED BY: Dario DiMaggio	DATE: 12-15-00			
APPROVED BY: Bruce Burton	DATE: 12-15-00			

In-Situ Field Calibration

1.0 Purpose:

This procedure defines how an insertion flow meter may be checked or calibrated as installed in the application, or in-situ calibrated. This process allows the absolute accuracy to be set based on local factors which influence the readings, velocity profile for example.

2.0 Scope:

This procedure is intended for use by engineers and technicians who are familiar with performing velocity traverses for the reference flow measurement and can setup the correction factors in the program mode of the 155 Mass Flow computer. The general method and a specific example using a Kurz 2440 as the traverse point-velocity meter in a round and rectangular duct are provided.

3.0 References:

LD-0001	Fissile Material Storage Facility, FE/FT-P1
LD-0002	Fissile Material Storage Facility, FE/FT-B1 & FE/FT-B2
LD-3601	Series 155C-2 Summary Guide
LD-3602	Series 2440 Summary Guide

4.0 Procedure:

Outline:

1. Measure the average flow or velocity with a reference method at each flow rate of interest and the DUT (Device Under Test) indicated flow rate at the same time.
2. Enter the reference velocity and indicated velocity of each K-BAR sensor for each flow rate or system operating point.

4.1 Velocity Traverse Reference Method

A popular method to compute the average velocity in a large process duct or stack is to perform a velocity traverse. In its classic form you divide the duct area in to equal areas then measure the velocity in the center of each equal area piece. The average velocity is computed by numerically averaging the data (sum the data and divide by the number of samples).

Alternately you can take the data at convenient positions (recording both the reading and position) then numerically integrate the data. This method allows you to do a traverse at convenient locations, ie 50, 100, 150, 200, 250, mm insertion points instead of the equal area, location centers, which are not uniform values. A computer program is used to curve fit the observed velocity profile then integrate the flow and compute an average velocity. If the same convenient locations are use for all traverse ports and for all flow rates tested, less data needs to be entered in to the program for evaluation. This alternative method will not be described here as it requires numerical integration methods/tools best done by a computer program like MathCad.

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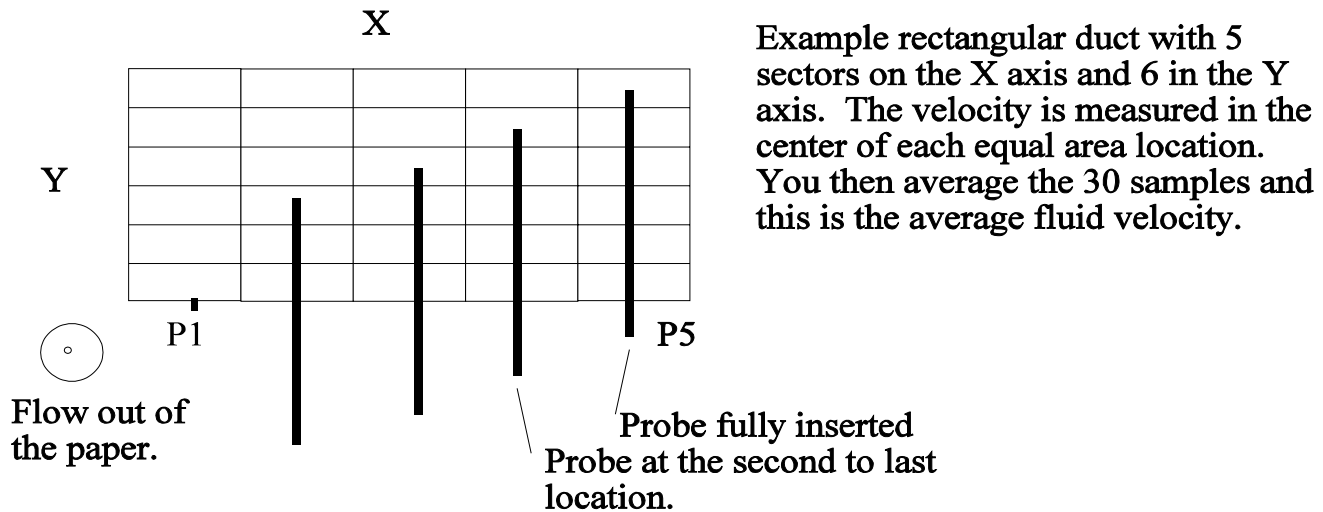
4.1.1 Equal Areas Rectangular Duct

For rectangular ducts, it is easy to compute equal area sample locations based on slicing the duct into small rectangles then measuring at the center of each rectangle. The insertion depths for the equal areas are uniformly spaced. If you have enough access ports, you can take the duct cross section and cut it up on both X and Y axis which are perpendicular to flow. We are defining Z as the axis along the flow. An example test matrix might have 10 positions on the X axis (different insertion depths) and two access ports on the Y axis allowing a total of 20 points.

$$P_i = X[i/N + 1/(2N)]$$

where i is the specific sensor location starting at $i = 0$ to $N-1$, N is the number of points in the cross section and X is the ID in the dimension of the cross section.

Example:



Using FE/FT-P1 on Kurz drawing No. LD-0001 we use the following locations. The recommended access ports have been defined on the drawing too. These are 19.1 mm (3/4") compression fittings with a Nylon, Teflon or other plastic ferrel which does not swage on to the 19.1 mm test probe.

So for 1000 mm ID in the traverse axis, assume six insertion depths we have:

1. $1000(0/6 + 1/12) = 83$ mm
2. $1000(1/6 + 1/12) = 250$ mm
3. $1000(2/6 + 1/12) = 417$ mm
4. $1000(3/6 + 1/12) = 583$ mm

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- 5. $1000(4/6 + 1/12) = 750$ mm
- 6. $1000(5/6 + 1/12) = 917$ mm

To put this all together, we collect data at each traverse port, at each insertion depth as defined below:

Flow Rate 1, 30 points (75 max per set, see section 4.1.4.1)

Insertion Depth (mm)	Port 1	Port 2	Port 3	Port 4	Port 5
83					
250					
417					
583					
750					
917					

From this table we compute the average fluid velocity by summing the data and dividing by the number of points. The 2440 portable will do the data logging and math internally (see section 4.1.4.3).

This process is repeated at each flow rate, up to four sets using CCF in the 155 (LD-3601)

4.1.2 Equal Areas Circular Duct

To compute equal areas on a circular duct you are working with a flow ring. The rings are closely spaced in radius near the outside edge or wall of the duct and spread out as you reach the center of the duct. You can also sector the duct into equal slices like a pizza in addition to the radial rings to get an even better average velocity calculation. Test ports at 90 ° spacing will allow four sectors then you take data at the equal area radius corresponding to the number of rings to acquire. For an odd number of radial data points we use the following equation.

$$R_i = R [(2i+1)/2N]^{0.5}$$

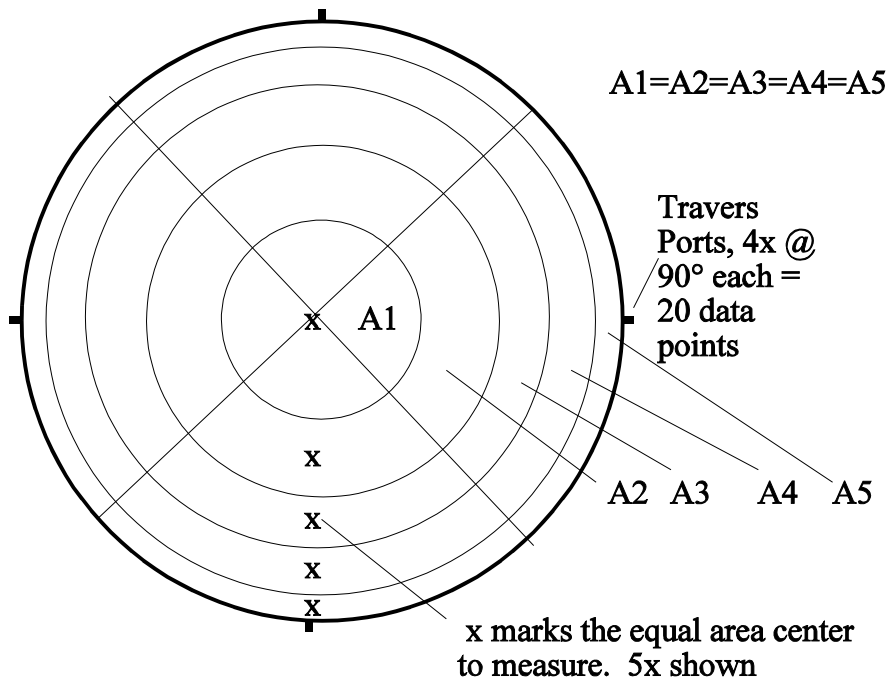
where i is a positive integer from 1 to N-1 and the duct center is the Nth point.
 R is the duct radius, N is the number of points..

The above radial locations are at the center of each equal area location.

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Example: For a 1400 mm ID duct (FE/FT-B1 and FE/FE-B2, on Kurz drawing No. LD-0002) we would measure at the following locations. Using five equal area locations on each of four sectors or traverse ports makes 20 total measurement points. The following radial locations are needed for equal area points.

1. Duct Center, 0 mm radius
1. $700[(2+1)/10]^{0.5} = 383$ mm
2. $700[(4+1)/10]^{0.5} = 495$ mm
3. $700[(6+1)/10]^{0.5} = 586$ mm
4. $700[(8+1)/10]^{0.5} = 664$ mm



Equal areas for a circular duct are measured in the center of the area. Radial locations scaled by r^2 .

The duct is further divided in equal size angular sectors for better localized measurement of the velocity.

Velocity average is just the numerical average of all the data points, 20 points in this example.

The corresponding traverse insertion depth is then the duct radius less the radial location or:

$$\text{Insertion depth} = R - R_i$$

1. $700 - 0 = 700$ mm insertion depth
2. $700 - 383 = 317$ mm insertion depth
3. $700 - 495 = 205$ mm insertion depth
4. $700 - 586 = 114$ mm insertion depth
5. $700 - 664 = 36$ mm insertion depth

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A data chart like defined for the rectangular duct (4.1.1) can be made and used. Again, you would repeat the whole process for each flow rate or system operating point up to a maximum of four flow rates.

4.1.3 Velocity Traverse Data Acquisition

Once the number and location of the equal area center points are known they will be used to position the probe at the center of each area.

During the traverse procedure, the process flow rate must be at equilibrium so the computed average from the travers is for the same flow rates on all test ports. The traverse average velocity is obtained using either the rectangular duct or circular duct methods described above. The indicated average velocity on the device being calibrated (the 155C-2) is recorded by logging each sensor's velocity while the traverse is performed. See LD-3601 on the 155 which describes how to setup the log interval and record it on a computer or printer.

4.1.3.1 Traverse Probe Blockage:

For small ducts, the sensor and probe support blockage must be accounted for. As the probe is inserted deeper in the duct, it blocks off more of the flow causing an increase in local velocity due to the smaller duct area.. A correction factor can be defined to convert the observed reading to that which an ideal (no blockage sensor) reading would have been. To first order, a sensor blockage correction factor (SBCF) can be defined as follows.

$$\text{SBCF (d)} = (\text{Area} - d \cdot w) / \text{Area}$$

where

Area is based on the ID,
d is the insertion depth and
w is the probe diameter.

$$\text{True velocity} = \text{Indicated} * \text{SBCF (d)}$$

Example: For a circular duct whose diameter is 1000 mm, and a 19.05 mm (3/4") diameter probe inserted half way, this CF = $(\pi \times 500^2 - 19.05 \times 500) / \pi \times 500^2 = 98.79\%$ or 1.2 % error if ignored. Since this only represents a small part of the total number of samples which have even less blockage, this factor can be ignored for this example, the estimated error is less than 0.25%. The increase in accuracy is not worth the extra computational trouble.

4.1.4 Velocity Probe type, Series 2440

A thermal anemometer which reads standard velocity corrected to reference conditions used at Kurz is very convenient (0 °C, 760 mmHg). The readings are logged, then directly averaged using the equal area method.

To use the insertion depth information in the above example you must note the center of the velocity probe sensing element. The center of the sensing location on the sensor is 20 mm from the probe end. This start point is Y mm beyond the compression fitting's outside edge (site specific depends on duct wall thickness and

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tread adaptors used etc.). Once the probe center is located at the near wall edge, you mark the zero on the probe support when flush with the compression fitting collar. Then you just mark the computed traverse locations on the probe using a tape measure with a line. A permanent marker pen or finger nail polish works fine.

The 2440 portable flow meter can average a set of traverse data of equal areas by simply setting up a *test-set* memory log whose size is that of the traverse array. This method is faster and less error prone than filling out a table as shown above and computing the average by hand. The following sections define how to do this.

4.1.4.1 Configuring the 2440.

To configure the 2440 to internally log data to its test-set memory, you must do the following: Setup the internal memory log for enough memory to cover the traverse size. The internal memory log has 1500 points split between trending and test-set data point storage. Say at least 10 % of the 1500 point internal memory size is allocated to test-sets which is programmed as 90 % max. to trend memory. Then the test-set memory is turned on and a set number is defined with the total number of traverse points needed for the test.

Specific steps for configuration of the 2440 are:

First you press **P** for program mode then the user access code **123456** followed by the **E** or the enter key then advance thru the program menus with the **P** key till you see the menu category:

**PRESS E TO SET
MEMORY DATA LOG**

and press **E** to enter. The next menu is:

**SETUP: EVENTS
NEXT CHOICE ^v**

and your choices are for EVENTS which are alarms, kickouts etc, TESTS which are the test-sets we will be using for logging our traverse data and TRENDS which records the real-time history at a programmable time interval to the internal memory. You select **TRENDS** using the **^v** keys followed by **E** to accept this area. Next you see:

**TRENDS LOG: ON
^=ON v=OFF**

You turn the trends **ON** with the **^** key followed by **E** key. You will see a warning screen that says:

**LOG DATA MAY BE
LOST IF CHANGED!**

which is the currently stored data in the internal log. You pass the screen with the **P** or **E** key. The next

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screen:

**ENTER PERCENT OF
MEMORY USE: 0**

defines the percentage of internal memory allocated to trends, select 50 (or 50% of the 1500 total internal data records possible) by typing the **5** key and **0** key on the 2440 front panel followed by **E** to accept this. Now use the **P** key to advance past the trend interval time screen:

**ENTER INTERVAL
TIME(S): 60**

You should now be back at the:

**SETUP: TESTS
NEXT CHOICE ^v**

menu and if not navigate the this then press **E**. Next you turn on the test-set memory by pressing the **^** key at the menu:

**TEST LOG: ON
^=ON v=OFF**

followed by **E** to accept the entry. You will see the memory log warning screen:

**LOG DATE MAY BE
LOST IF CHANGED!**

which you pass by pressing **P** or **E**. Now you specify the number of test-sets to use (the test-set memory will be split into this many equal size sets). The screen will read:

**ENTER MAX # OF
TEST SETS 10**

Use the default 10 followed by **E** for now (this splits the 50% of 1500 into 10 units of equal size or 75 samples). You should see the screen which says:

**MAX. SAMPLES PER
TEST SET IS 75.**

Press **E** or **P** to clear this screen. You now press **C** to leave the SET MEMORY DATA menu category. You should now see the screen:

PRESS E TO

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ACCESS MEM LOG

which is where we start to record data during our traverse.

While we setup the 2440 for 10 test-sets, the configuration correction factor CCF software on the 155C-2 will only allow up to four flow rates to be field calibrated so we will be using four or less test-sets. Alternately, you could save the results of each traverse on paper then keep using the same test-set number for all flow rates on each duct to be calibrated.

4.1.4.2 Storing data in the Test Memory.

If you are not all ready in program mode at the menu category:

**PRESS E TO
ACCESS MEM LOG**

then go there now and press **E** to enter. The screen will say:

**SELECT TASK ^v
VIEW TEST DATA**

and you use the **^v** keys to chose **RECORD TEST DATA** followed by **E** to accept this task. Now you chose which test-set identification number

**ENTER TEST SET
NUMBER: 1**

(1 to 10 based on our previous setup) followed by **E** to chose which test-set memory to record. If you have data already stored in the test-set number selected, you will be asked if you want to **OVERWRITE** the data where you can say **YES** or **NO** with the **^v** key and then press **E** and select. You will be ask for a different test-set number if you said **NO**. Now you chose the specific traverse array size for this specific test-set

**ENTER # OF TEST
SAMPLES: 30**

(This should be less than 75 based on our previous setup example of 750 records/ten). The next screen will ask if the:

**LOG IS AUTO: NO
^=YES v=NO**

and select **v** for **NO** and **E** to accept this. We do not want an automatic time spaced logging unless you want both hands on the probe and can move to each point on the time interval you specify in the following screen. Now you will see the screen you have been waiting for:

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**PRESS E TO START
AND E TO RECORD**

following this screen after pressing **E** you will see:

**10.98 SMPS
24.6 DEGC**

the velocity and temperature filtered to the settings of meter filter values set elsewhere. Each time you press **E**, you will see a momentary menu:

**SAMPLE #2
IS RECORDED**

stating which test-set number you just logged and this will continue until the whole test-set has been defined. This data viewing screen can be changed from velocity/temp to temp/flow or flow/velocity by pressing the **^v** keys. This allows you to see any two of the three variable on the screen and you can switch back and forth if you like while taking data. When recording data into the test-set memory, the 2440 will hold at the selected display screen indefinitely until all the data for the test-set are entered. Other menus under program mode will automatically exit after two minutes of inactivity.

After a test-set is completed, the unit will be back at the screen to select which memory log task you are interested in, record test data, view test data or log to com port.

Note that the above data were acquired while the device under test (155C-2) was being monitored with its Log Command.. Its individual sensor channel velocity will be used to with the average velocity from the traverse to compute the correction factor for this flow rate on each input channel of the 155. You can log this to a PC using a terminal emulator program which comes with Windows like HyperTerminal. You set the 155 for a one minute log interval then plug the logging computer or printer into the data logging serial port.. See the 155C-2 summary guide, LD-3601 for more on this topic.

4.1.4.3 Viewing the data stored in the Test Memory

To view the internally stored data from a test-set, you must enter *Program mode* and advance to the following screen:

**PRESS E TO
ACCESS MEM LOG**

You press **E** to enter this menu category which will preset the next screen:

**SELECT TASK ^v
RECORD TEST DATA**

where you use the **^v** keys to chose **VIEW TEST DATA** followed by pressing the **E** key. The next screen

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will be the test-set number to view followed by **E** to accepted this:

**ENTER TEST SET
NUMBER: 1**

So you select the test-set of interest where you will then select what variable to view:

**VIEW:VELOCITY
NEXT CHOICE ^v**

and you use the **^v** keys to select from: VELOCITY, TEMPERATURE or FLOW RATE, chose **VELOCITY** followed by **E** to accept this. You will next see the average velocity

**AVERAGE DATA
10.879 SMPS**

then press **E** to advance to the next parameter of the velocity which will show the standard deviation, then the Maximum value followed by the Minimum value and the individual array data points will be shown. For our purposes, we need to note just the average velocity.

4.1.5 Entering the data in the 155 Flow Computer.

The 155C-2 Summary guide, LD-3601, explains how to navigate the 155C-2 menus to load the data in the CCF section of the METER being field calibrated.

In summary, you take the average velocity computed from the traverse (2440 data), and the individual sensor channel velocities (acquired with the 155 data log, one minute summaries) and enter this at the CCF menu prompts.

If data were taken at other average velocities or flow rates, they too would be entered into the 155 as another data set up to a maximum of four data sets.